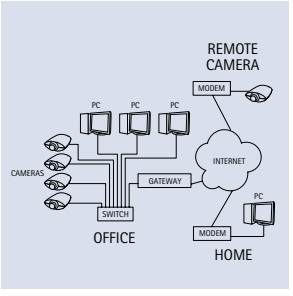
Network Video Solutions

Technical Guide



AXIS® COMMUNICATIONS

About Axis video products

Axis was founded 1984 in Lund, Sweden. Axis currently has more than 300 employees and subsidiaries in 14 countries all over the world.

Axis Communications designs and manufactures network products, such as network cameras, video servers, print servers, document servers, and storage servers.

Axis started developing and selling network cameras in 1996 and is now the worldwide leader in network cameras and video servers. We have more than 200,000 units installed worldwide and work with world-class partners such as Sony, Canon and Honeywell. The AXIS 2400 Video Server won the Best of Show award at the 1999 ISC EXPO/New York.

The products are based on Axis' ThinServer Technology for network connection. More than 200 engineers work with the software, hardware and the ASIC's used in Axis' products. Over 2 million units worldwide currently use Axis' ThinServer technology.

Foreword

For over 20 years, analog surveillance technology (CCTV) has been used for a wide range of video and audio applications. However, now that the vast majority of organizations have IP networks, a new generation of network video products has emerged. These are based on digital technology and offer an excellent, cost-effective alternative to CCTV.

This guide highlights a few of the advantages of this new technology, and describes the working principles behind network video products. It also explains some of the common concepts and terminology concerning digital images, compression standards, lenses and much more besides.

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The state of network video solutions

Today, it is possible to install a camera in almost any remote location and view its images from your PC, either at home or from the office.

Network cameras are designed with built-in computers, enabling them to connect directly to any IP-based network. Video and audio transmitted from any network camera or video server can be viewed from any computer connected to a local network, or over a private Intranet or the Internet.

A network video product can be configured to provide the entire Internet community with access to its images via a Web site, or alternatively to provide restricted viewing access to a limited number of authorized people. If a building is equipped with a computer network, the necessary infrastructure is already in place to add network video products. These can be used in an almost unlimited number of ways: for example, to track every person that passes the office door by taking their picture, or to check for false burglar alarms without leaving your desk.

THINSERVER TECHNOLOGY

Axis' unique chipset design

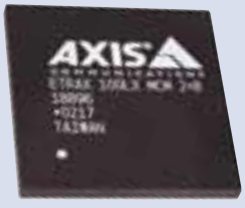
When product development first began, Axis needed to create its own unique chipset in order to produce a high performance network camera. Today, Axis continues to develop and design its chipset technology for use in Axis-branded and other OEM-branded partner products. It is this development expertise and the resulting cutting-edge technology that accounts for Axis' success in the market for wired and wireless network connectivity.

The on-board AXIS ETRAX 100-LX processor combined with the AXIS ARTPEC-1 (Real Time Picture Encoder) provides the power synergies that deliver up to 30 frames/second over 10 Mbps or 100 Mbps networks.

Providing integrated Ethernet networking and extremely flexible I/O functions, Axis also offers this technology to customers looking to develop their own network applications for wired or wireless peripherals. For further information, please visit our developer site at: www.developer.axis.com

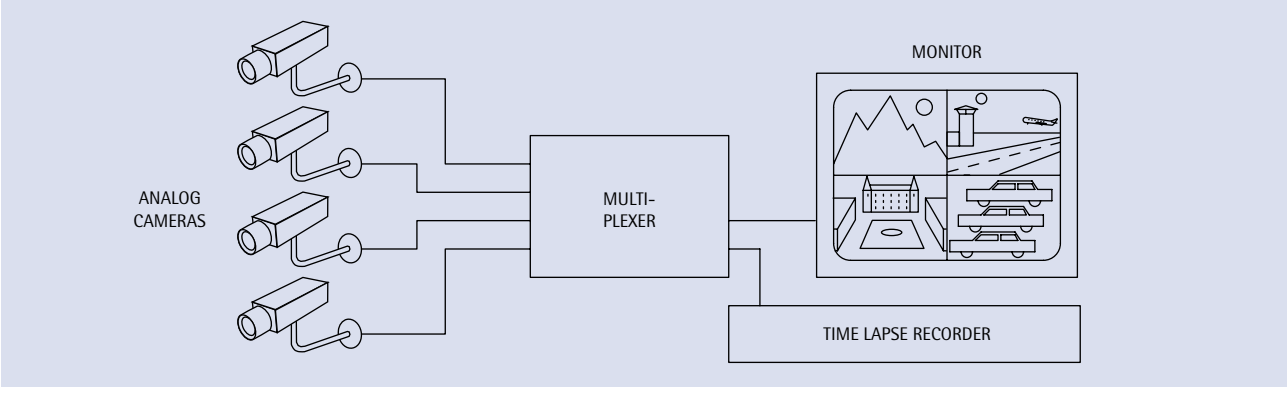
Linux-based operating system

The software used in Axis' network products is Linux-based. Continuously tested and updated by thousands of software engineers the world over, the Linux operating system helps make Axis network video products safe and reliable. The system's increasing popularity makes it easier for developers to create compatible application software. Moreover, it allows the basic functionality of Axis' network cameras to meet specific end-user requirements. See also page 17.



An AXIS ETRAX 100LX MCM 2+8 RISC processor, optimized for network products.

An AXIS Real Time Picture Encoder, ARTPEC-1.



A typical CCTV system comprising analog cameras, multiplexer, monitor and time-lapse recorder.

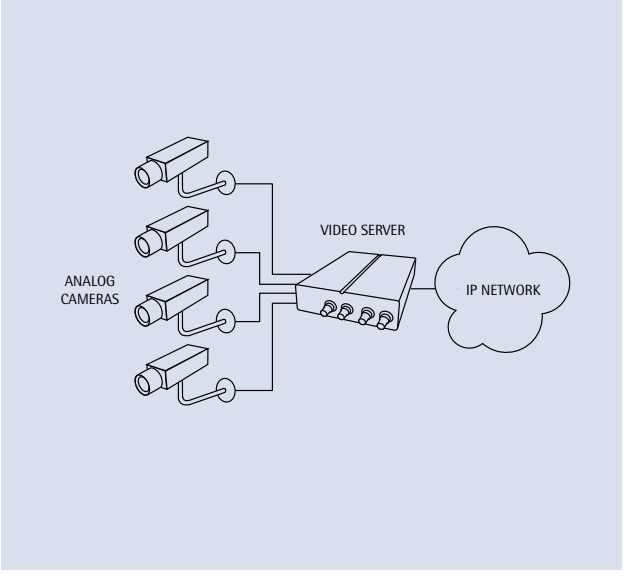
Traditional CCTV installations

Traditional surveillance (CCTV) cameras are usually connected to a monitor, using dedicated coaxial cabling. Where a multiplexer is used, several cameras can be displayed on a single monitor.

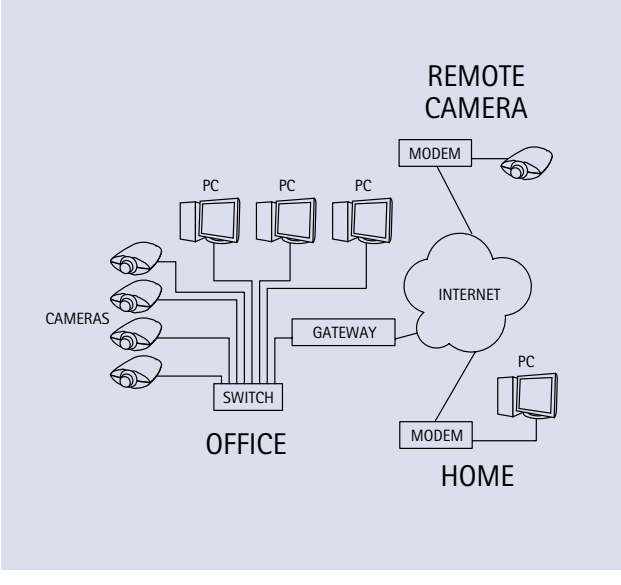
It is relatively easy to add one or two more monitors within a building. Viewing images from additional outside locations becomes progressively more complicated. That is because dedicated cable is required to add a new monitor or camera to any existing system. In addition to this, CCTV users must always consider how to handle the storage of large quantities of magnetic tape.

Upgrading existing CCTV systems using network video products

A PC installed with professional network video application software is connected to the IP network in order to retrieve, manage and replay digital video from all the system's cameras. Digital video is stored on an external hard disk, directly on a resident PC, or to any dedicated server over the network. The flexibility and scalability of network video solutions enables convenient, piecemeal upgrades to be made from an existing analog to a new digital system.



An Axis video server connects to existing analog cameras to digitalize and transmit the video over the IP network.



A typical surveillance configuration using network cameras. All cameras can be seen and managed from any computer on the network. It is possible to extend viewing and management access to include any remote PC in the home or office.

Why use network video technology?

Remote accessibility
You can access up-to-the-second images at any time from any computer anywhere. The images can be stored at remote locations for convenience and/or security, and the Internet can be used as carrier for the information.

Flexible
A camera can be placed almost anywhere. There are no limitations tied to physical inputs or frame grabbers; you can connect the product to a LAN, xDSL, modem, wireless adapter or cell phone. Anywhere that you can receive a phone call or an SMS on your mobile phone, you can receive network video images.

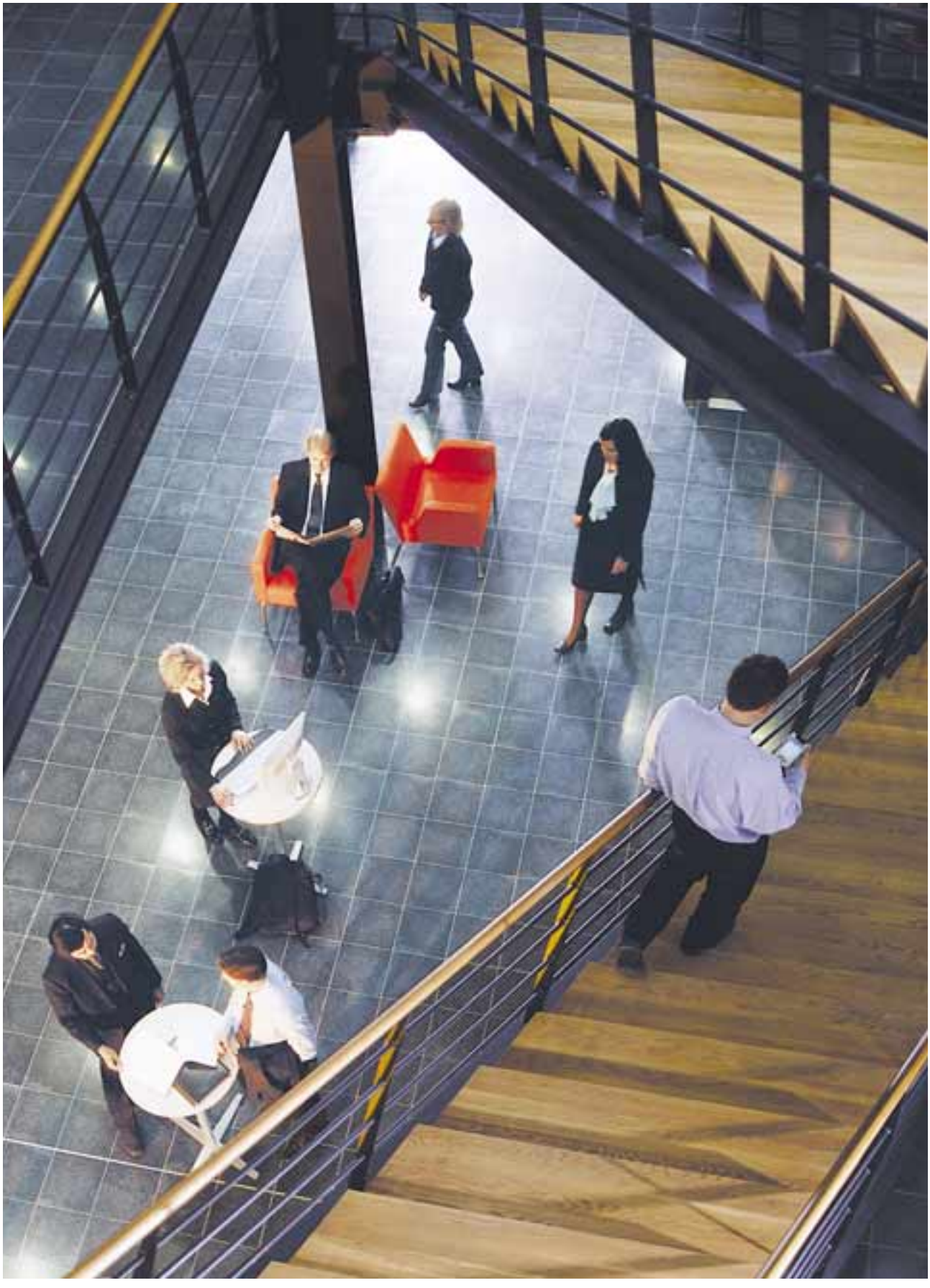
Cost-effective
Network video technology is highly cost-effective, since you do not even need a PC to make the camera usable. For viewing video images, existing computers can be used; there is no need to buy dedicated video monitors. Existing network cabling can be used for transmission; no separate coaxial cables are required.

Convenient hard disk storage
For storage purposes, a computer hard disk has the advantages of being more durable than VCR and magnetic tapes, configurable for constant hot standby (to minimize redundancy) and is easy to back-up.

Scalable
A network video system can be expanded by just adding capacity. The scalability of this technology makes it an equally practical option for large organizations using thousands of cameras, as it is for small businesses employing only a few. It also makes for easy, step-by-step upgrades from an existing analog to a new digital system.

Future proof
Since network cameras use modern digital technology, today's investments will yield long term benefits.

Many uses
The beauty of network cameras, besides the numerous practical and cost advantages, is that they can be used in such a broad variety of different situations.



What is a network camera?

A network camera is a device containing a camera, compression chip and a computer. The computer is small and specialized for network applications.

A network camera has its own IP address. It is connected to the network and has built-in software for a Web server, FTP server, FTP client, e-mail client, etc. It can even run customized scripts (small programs).

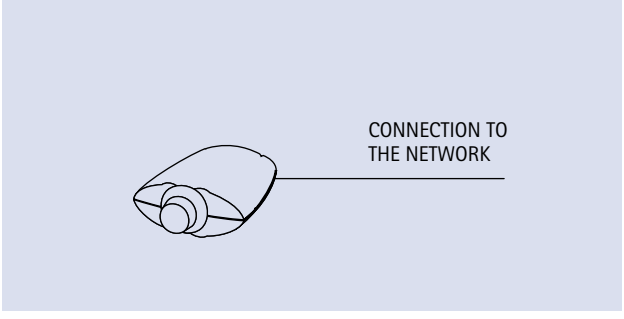
A real network camera does not need to be connected to a PC. Note that many Web cameras and Internet cameras, claiming to be network cameras, are in fact simple PC cameras that require connection to a PC via a USB or printer port connection. For these products, a PC is needed for connection to the network.

Network cameras are equipped with digital inputs and outputs. The digital inputs can be used to trigger the transmission of images from the camera.

Digital outputs can be used for instance, to open a door remotely, or to turn on a light inside a building when viewing images remotely.

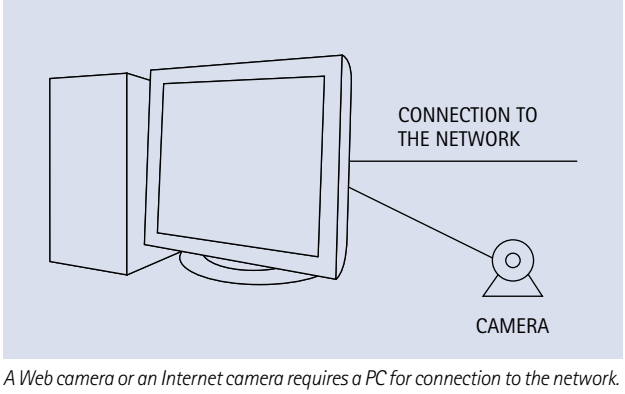
Network cameras with image buffers can save and send the images which were collected before an alarm occurred. See also Triggering Mechanisms on page 16.

True Network Camera



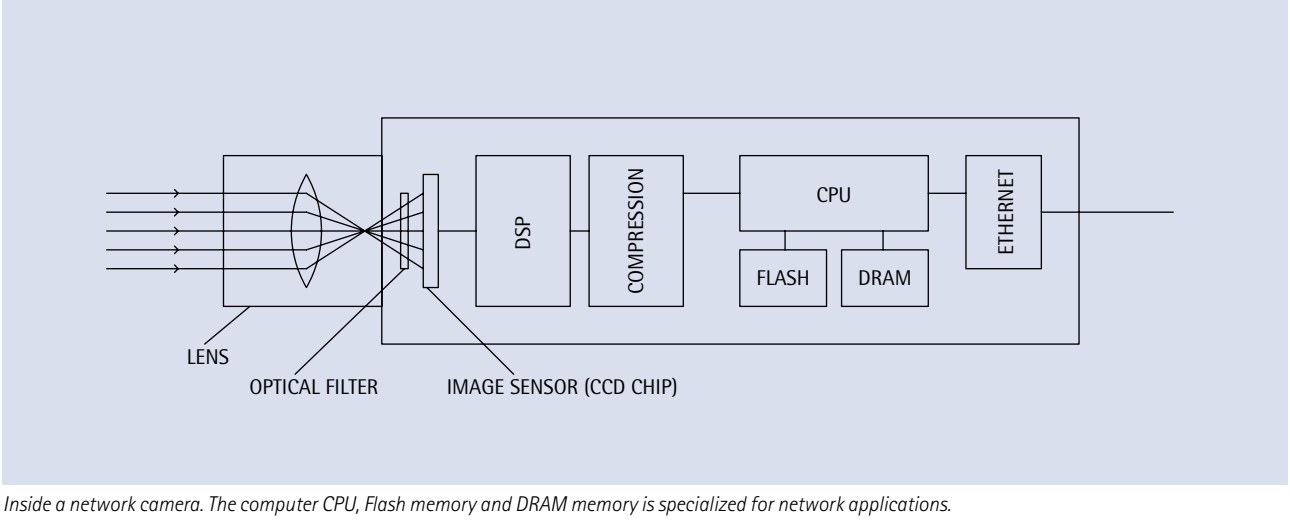
With a network camera, everything needed for viewing images over the network is built into the unit.

PC based camera



A Web camera or an Internet camera requires a PC for connection to the network.

Camera components



Inside a network camera. The computer CPU, Flash memory and DRAM memory is specialized for network applications.

What is a video server?

Analog CCTV systems are already in use in numerous different working environments. To transmit the images from these systems over the network, a video server can be installed. The video server connects in parallel with the existing equipment and transmits the analog video sources over a computer network.

By utilizing the built-in serial ports of a video server you can control existing equipment such as Pan/Tilt/Zoom (PTZ) devices or time-lapse tape recorders.

Video servers are equipped with digital inputs and outputs. The digital inputs can be used to trigger the transmission of images from the server.

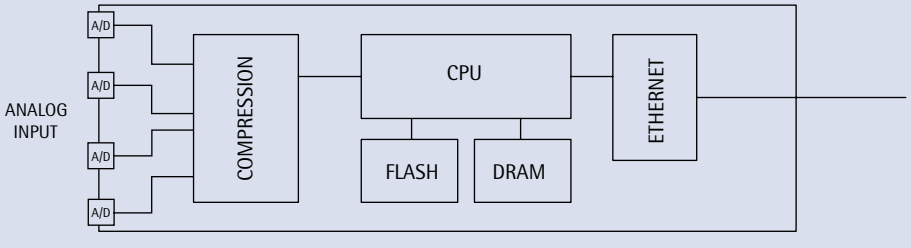
Digital outputs can be used for instance, to open a door remotely, or to turn on a light inside a building when viewing images remotely.

Servers with image buffers can save and send the images, which were collected before an alarm occurred. See also Triggering Mechanisms on page 16.

A video server can also be connected to a wide variety of specialized cameras such as, a highly sensitive black and white camera, a miniature camera, or a microscope camera.

A video server is ideal for enhancing any existing CCTV system.

Video server components



Inside a video server. The difference from a network camera is the A/D converters for four analog cameras, replacing the camera part.

Security surveillance

False alarms present a big problem to security systems. Network cameras and video servers enable alarms to be checked from anywhere before action is taken. They are equally well suited to taking snapshots of people passing through a door, as they are to being used in sophisticated biometric systems with dedicated application software.

A security guard who has been alerted to a break-in in a building, can get a view of the room where the break-in has occurred by checking video images sent to his wireless PDA. This way, he knows whether or not it is safe to enter.

With network video products there is no longer any need to worry about changing (or forgetting to change) tapes in time-lapse recorders. By storing the images on hard disks, instead of VHS tapes, any old unwanted images can be erased automatically.

Delivering live high-quality images and sound, network video is ideal for improving school and campus security. In combination with a security firewall, network cameras can be quickly configured for securely monitoring hallways, classrooms and parking lots.

Use network video for access control. People, places and property can be remotely monitored and recorded with a time stamp authentication. As opposed to storing images locally, they can be stored securely in any remote location over the network – in a place where they are, additionally, less at risk of being stolen.

Use network cameras to protect personnel from crime in banks, casinos, and shops. By using network cameras with built-in motion detection, video recording can be triggered to start up whenever significant movement occurs in the displayed image area. Doorbells, switches, and temperature sensors can also be used as external triggering mechanisms, connected via the I/O ports.

With a PDA and WLAN security guards can view a room before entering.

Inexpensive network technology can be used to enhance and extend the useful life cycle of existing CCTV systems. The CCTV transmissions from an underground subway station can be made available to viewers in any control room, ticket office or police station. With network video products, train drivers can view images from their trains, and security managers can work from home.

Remote monitoring

Network video can be used for thousands of applications. Simply attach a camera to an existing IP network and view live video on your PC. No extra software is needed. You can just use the Internet browser.

Use network cameras in schools to see who is in the hall, computer room, lab or cafeteria. Use it at manufacturing plants to see that production is running smoothly, and that the machinery is performing as it should.

Remote monitoring in retail

By installing an xDSL connection and adding some network video equipment it is possible to monitor a shop, warehouse, or any other small business. Installing video cameras helps to keep store owners better informed, prevent theft and makes store management easier and more efficient. Such a system is particularly appreciated by employees working alone at gas stations. Knowing that their workstation is observed remotely increases peace of mind.

Free to choose local or remote video storage

With network video it is possible to transmit and store surveillance images to a geographically remote server over the network, making it impossible for a thief to steal surveillance evidence.

In some cases, particularly where network bandwidth is limited, it may be desirable to store video images locally onto a network DVR (Digital Video Recorder). This solution allows analog video sources to be converted and stored locally as digital recordings, where they can be accessed from any secure location over the network at any time.

How to connect

Once your ISP (Internet Service Provider) has installed the xDSL connection, you are equipped with a modem and an Ethernet connector, which can then be connected directly to a switch. The ISP will also provide you with information about IP addresses, etc.

Using motion detection

A more sophisticated solution that effectively eliminates the need for a microswitch, would be to use an advanced network camera with built-in motion detection, such as the AXIS 2120. Using in-image window-triggering, these cameras can be programmed to capture an image whenever motion is detected within a sensitive area of the shop: for example, at the checkout or within staff restricted areas.

Microswitch trigger

Three network cameras are added to improve surveillance coverage in the store. A micro-switch installed on the shop door is connected to the I/O interface of the network camera capturing digital images of everyone entering the shop.

E-mail notification

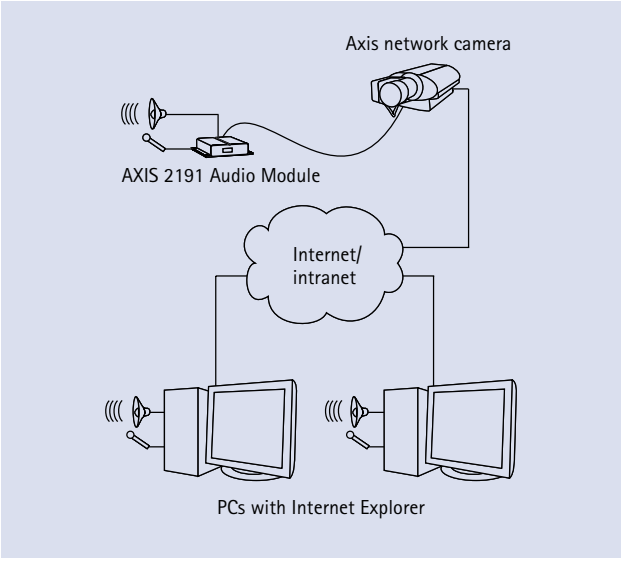
Network cameras and video servers can be programmed to send images via e-mail at regular time intervals or in response to an alarm. The e-mails are sent to the ISP and can be forwarded to any address.

Network video in offices

A network camera is a useful tool at the office. You can use it, for example, to keep track of who has been in the server room, or to keep an eye on sensitive areas such as the reception or the goods entrance.

This technology can also be used in the office environment to add images to teleconferences. This makes it possible to participate in meetings remotely over a corporate Intranet. It saves the time and expense of flying key people around to branch offices on a regular basis.

A network video solution also allows the company's valuable IT equipment to be checked remotely. You can have a specialist give advice whilst watching real time images over the network.



Audio and video transmission via the Internet/intranet.

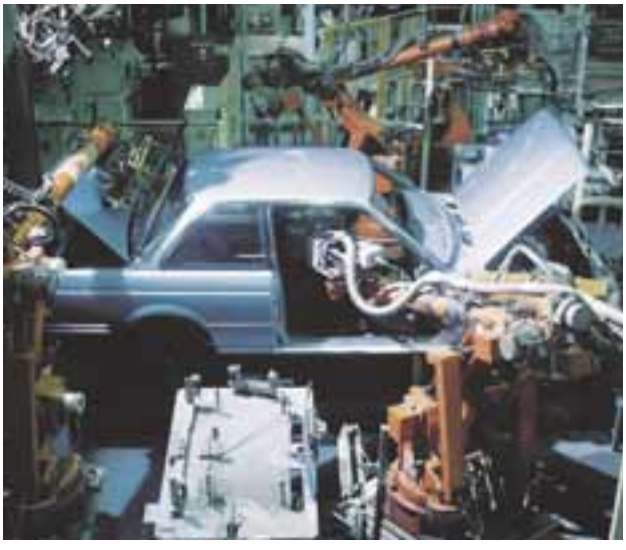
Manufacturing and industrial use

Network video is a useful tool for the manufacturing industry. Used for capturing and storing an image of any manufactured item it can serve as a quality control tool. Monitor robots and other machines from your office or home and allow service engineers to access the cameras remotely.

Using network cameras with external or built-in Pan/Tilt/Zoom support, you can monitor equipment over wide geographical areas and from multiple angles. With a single mouse-click, the cameras can be quickly re-orientated to focus on any detail.

Monitoring a server room using network cameras.

Use network cameras to modernize old equipment. Have cameras monitor analog meters, modems, control lamps, LEDs, displays or even computer monitors. It's easier and costs less to let a network camera watch a monitor, than to upgrade an old computer system.



Use network cameras for monitoring production. Integrate the images/video to your automation software and look at live video from your desk at work or home.

Broadcasting

Broadcasting images over the Internet is a great way for companies to promote their services, and to provide customers with up-to-the minute information. For example, cameras transmitting video of a ski station show the weather conditions on the slopes. People can check these by browsing the Internet before leaving home.

Stimulate the viewers' interest by broadcasting live video from network weather cameras. Publish live images and sound of a bustling city, a busy university, or show off the beauty of a mountain, beach, or forest. Live video makes a Web site attractive, dynamic, and interesting and encourages people return to the site.

Creating your own Web pages

Web sites or home pages displaying the images from network cameras are easily created using HTML (Hyper-Text Markup Language). A number of commercial software applications are designed to make the creation and publication of HTML pages easier; e.g. MS Frontpage, Macromedia Dreamweaver, etc.

Uploading images to a Web site with FTP

If you buy a Web hosting service from your ISP you can upload images directly from your network camera and show them to the global Internet community.

The camera automatically transmits a new image every hour, minute or even second to a host computer connected to the Internet. The protocol used for uploading the images from the camera to your ISP is called the File Transfer Protocol (FTP).

About Web hosting

Several companies offer free Web hosting, but these hosting services normally limit available Web server space to typically 10 MB. Many also add some sort of banner advertising.

Index page examples

The following example explains one type of procedure for publishing live images from a network camera over the Internet, using a free Web hosting service called Angelfire.com

Weather city cameras.

Traffic cameras.

Live events.

Construction sites.

Hotels, resorts and tourism.

About Angelfire

Angelfire's free Web hosting service accommodates image uploading via FTP and authorizes image overwriting (which is necessary for live image publishing). The service includes 20 MB of free Web space with a chance to extend this for an added cost. Free publication is subject to the inclusion of banner advertising.

Creating the Index Page

The following index page was created and subsequently published at angelfire.com. (Please note that this is just an example to demonstrate the process involved.)

```
<head>
<head>
<title>Index.html Buffalo, NY, USA</
title>
</head>
<body>
<h1 align="center ">Weather cam,
Buffalo NY</h1>
<p align="center ">
```

This picture shows Elmwood Street in Buffalo, NY, USA. Buffalo is very close to the famous Niagara Falls and it is known for its winter weather. The image is updated every hour.

```
</p>
<p align="center "><img border="0
"src="elmwood.jpg ">
</p>
</center>
</div>
</body>
```

Signing up for a free Web page account

- Use your browser and connect to http://www.angelfire.com/
- Sign up for a free home page
- Choose a user name and password
- Answer all the questions in the sign up form
- Choose a URL (Web address)

When this is done, a free account with the following data has been created:

- User: `buffalocamera`
- Password: `hanna`
- URL: `http://www.angelfire.com/art/buffalo`
- Upload a home page to the web page account
- Create a home page called index.html (Must be index.html) with an image called e.g. elmwood.jpg (See index.html example file)
- Upload the file index.html to Angelfire according to their instructions

Remember to check Overwrite

Weather condition.

- Check that it worked by connecting to http://www.angelfire.com/art/buffalo
  The Web page you made should now be seen. The image will not be shown, because it does not exist yet
- Install the network camera
- Install the camera and assign an IP address e.g. `200.132.12.15`
- Access the network settings in the camera and enter this info
- Subnet mask: `255.255.255.0` (Normally 255.255.255.0)
- Default router: `200.132.12.1` (Same as Default gateway in your PC)
- Host name: `Axis Camera` (Can be anything)
- Domain name: `axis.se` (Can be anything)
- Primary DNS: `200.132.12.3` (Same as in your PC)
- Secondary DNS: `200.132.12.7` (Same as in your PC)
- HTTP port: `80` (Normally 80)

Program an application into the camera

- Enter this info using the wizard
- Continuously upload pictures
- Primary time enabled /Always /Every 1 hour(s)
- Secondary time disabled (no check in the box)
- Upload via FTP
- Host Name: `ftp.angelfire.com`
- User Name: `buffalocamera`
- Password: `hanna`
- Upload path: `(None,leave box empty)`
- Base File Name: `elmwood`
- Overwrite (check)

When this is done, the camera will start uploading images to the Web page.

The image will be stored with this address:
http://www.angelfire.com/art/buffalo/elmwood.jpg
If it did not work check that you can access the host, Angelfire.com

- Start a DOS window on a PC
- Type: `ftp ftp.angelfire.com`
- Enter user name: `buffalocamera`
- Enter password: `hanna`
- You should now receive the message `User 'art/buffalo 'logged on`
- Type: `dir`
- You should now receive a list of the files, e.g. `index.html` and `Elmwood,jpg`
- Type: `quit`
- This will end your session. You can also check the log file in the network camera
- Enter the home page of the camera. Click on the Administration tools
- Enter the log list, found under the support link

The PC and the Web browser

The speed and quality of images you get from your network video system is influenced by how modern your computer is. The PC can be running almost any operating system but it must have a Web browser, and it must be running IP.

The home page of AXIS 2120 Network Camera, remotely monitoring an office reception.

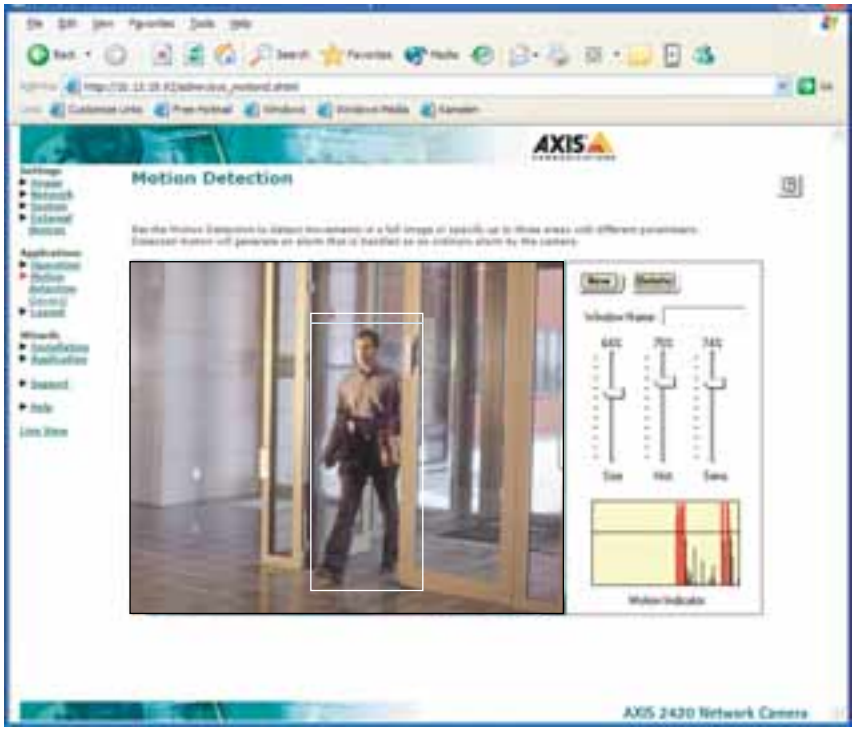
As all modern computers have network support and a Web browser installed when you purchase them, network cameras are easy to get up and running. If you have a modern PC and a network camera connected to the same network, all you need to do is assign an IP address to the camera. If you've done this before, it should only take a few minutes.

Detailed instructions on how to set the IP address will be supplied with your product.

To access a network once it's installed, simply start your Web browser (typically Internet Explorer or Netscape Navigator) and enter the IP address in the Address/Location field.

Once the PC has established a connection, the network camera's 'start page' is automatically displayed in the Web browser. This start page will display live video feed from the camera along with hyperlinks for changing the camera set-up, e.g. image resolution, network and e-mail settings.

Triggering mechanisms



The motion detection page of a network camera.

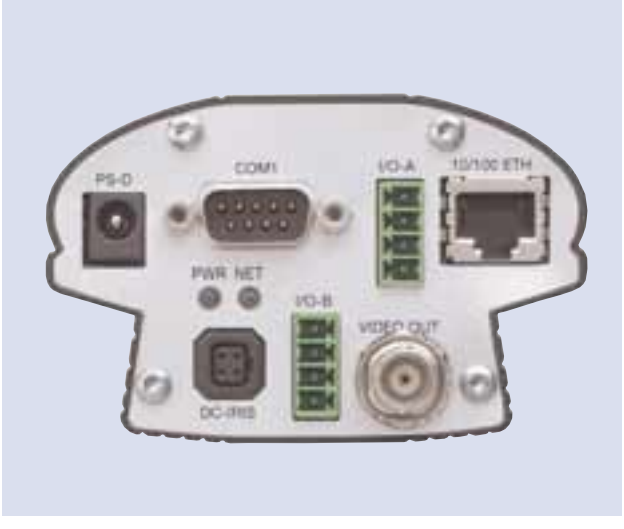
External I/O devices

Network video products may be configured to drive industrial relays and other devices via their I/O ports. The picture on the right shows the two I/O ports A and B.

Supporting most of today's common communication protocols like RS-232C and RS-485, many network cameras invariably include the physical interfaces for connecting a variety of external input and output devices; such as, Pan/Tilt/Zoom devices, doorbells, detectors, switches and alarm relays.

Motion detection

Advanced network cameras, like the AXIS 2420, also include built-in motion detection that supports in-picture alarm programming.



The back of an AXIS 2420 with I/O connectors.

Application software

A standard Web browser provides adequate viewing software for many basic video applications.

Applications that display several cameras at the same time are easy to design. To grasp the basics, just refer to one of the many books about using the Internet and HTML.

Using Visual Basic, you can create small applications, storing images and showing them in a simple way. Axis can provide you with templates and examples to help create such applications.

For other more sophisticated applications, extra Web pages or dedicated client software is required. In this case, you might turn to a specialized company for assistance. See also AXIS Camera Explorer, on page 46.

Application development

To make it easier for developers to integrate Axis video products into their applications, Axis has developed and now supports a standardized instruction suite of CGI (Common Gateway Interface) programs. These instructions collectively comprise Axis' Application Programming Interface (API).

In their simplest form CGI instructions for motion detection, event triggering, alarm notification via e-mail, remote picture storage and so forth, can be typed directly into the URL of a Web browser.

Example

The following URL entry instructs an AXIS 2400 Video Server (with IP address 121.222.222.222) to return a single image from camera 1 at a specified resolution and image size.

http://121.222.222.222/axis-cgi/jpg/image.cgi?camera=1&tresolution =320x240&tcompression=25

HTML, Java, Visual Basic or C++ programming

Given the amount of information that is now available on HTML and Java, it is quite simple to create unique Web pages with a variety of different functions. For example, showing images from several cameras, or creating multi-client access and control.

By using Visual Basic and C++ programming you can develop more sophisticated 'client application' software. (A client application is a program, or set of programs, that is installed and runs the computer to display the video images). These 'client applications' communicate at the same basic level with the Web server, using CGI.

A collection of useful application examples and documentation is available on the Camera and Video Developer pages on Axis' Website at: http://www.axis.com/techsup/cam_servers/dev/index.htm.

A typical example of a 'custom' Web page displaying images from several cameras.

Embedded scripting

The Linux-based operating system combined with the standard 'flash memory file system' inside Axis network video products, enables advanced users and application developers to create embedded scripts. These are additional files that are written and added into the read-write area of flash memory within the product. They tailor the functionality of network video products to meet specific needs. For example, you could create scripts for storing a predefined number of images in a network camera. These could then be uploaded to a computer over the network using FTP or SMTP.

	AXIS 2100/2110/2120/2130/2460/250S	AXIS 2400/2401/2420
Shell script	Release 2.30 and higher	Release 2.20 and higher
PHP3 script	N/A	Release 2.12 and higher

Axis network video products support two different types of embedded scripting: shell scripts and PHP3 scripts. Whereas PHP3 programming commands are quite familiar to Java and Windows developers, 'shell' programming has its roots in the UNIX world.

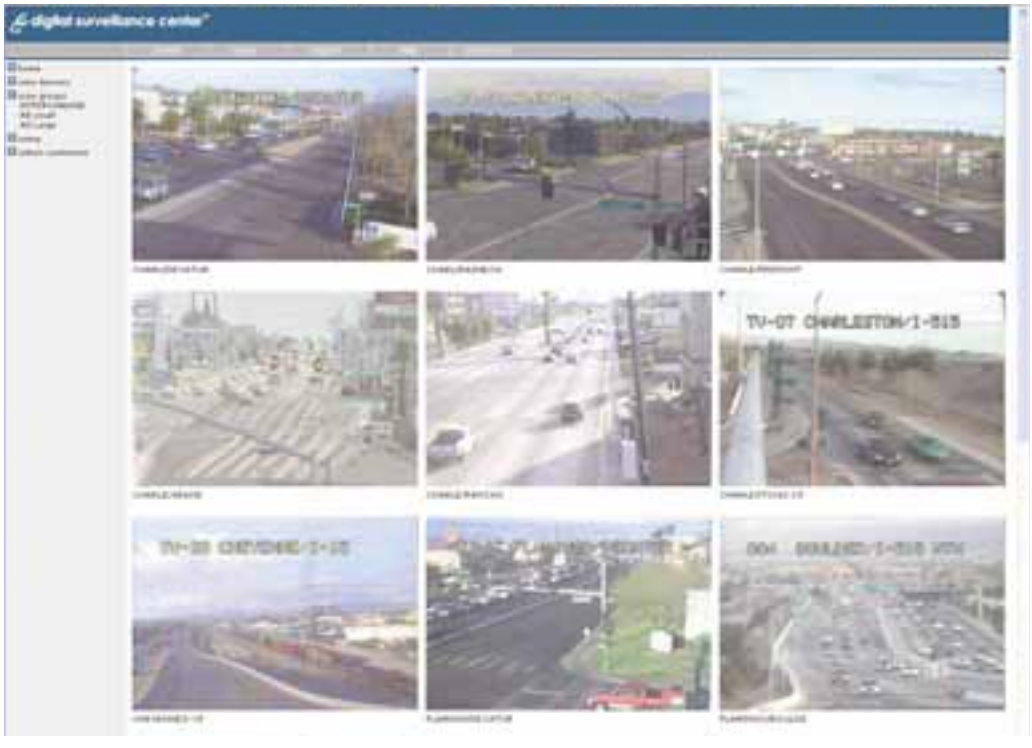
The table above shows the scripting method supported by each product model.

Important! The safe maximum for the number of 'writes' to the flash memory of an Axis network video product is estimated to be around 100,000. Developers are consequently advised not to exceed this number when writing temporary files to flash.

Axis Application Development Program (ADP)

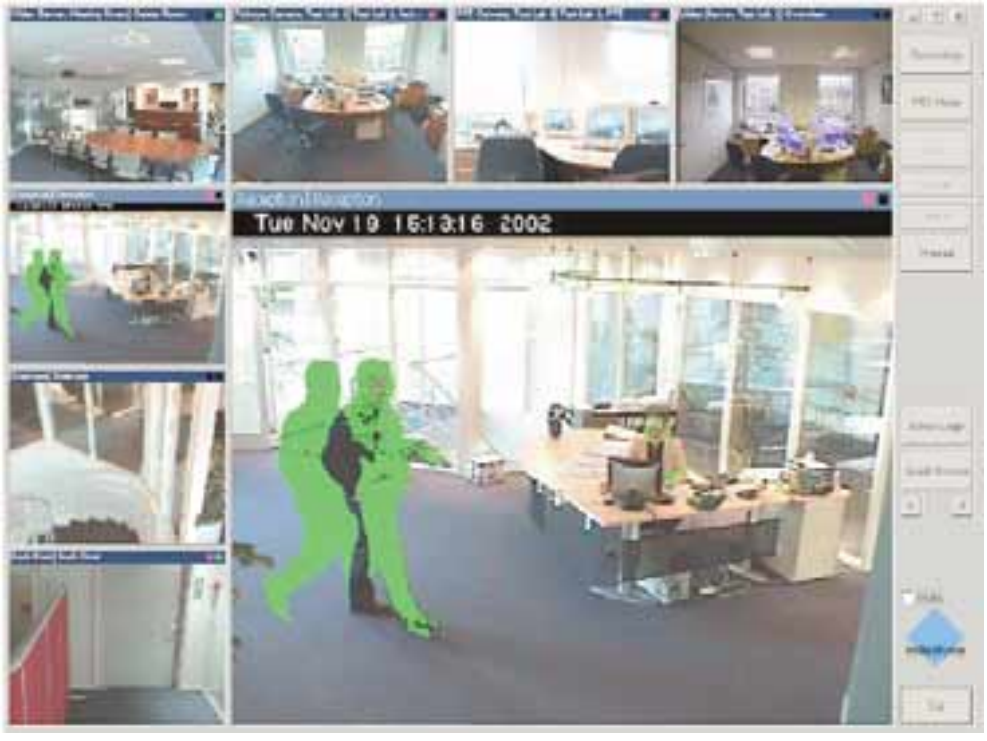
The Axis Application Development Partner (ADP) program includes a selection of global developers such as Honeywell, Lenel and Nice, as well as an interesting variety of medium-sized and smaller companies. Its purpose is to enable Axis to provide customers with a broad variety of application software and complete system solutions.

By working together with members of the program, Axis can offer anything from basic entry-level software to comprehensive professional applications in most business and industry segments. The examples below are a small sample of the ADP applications that are currently available.



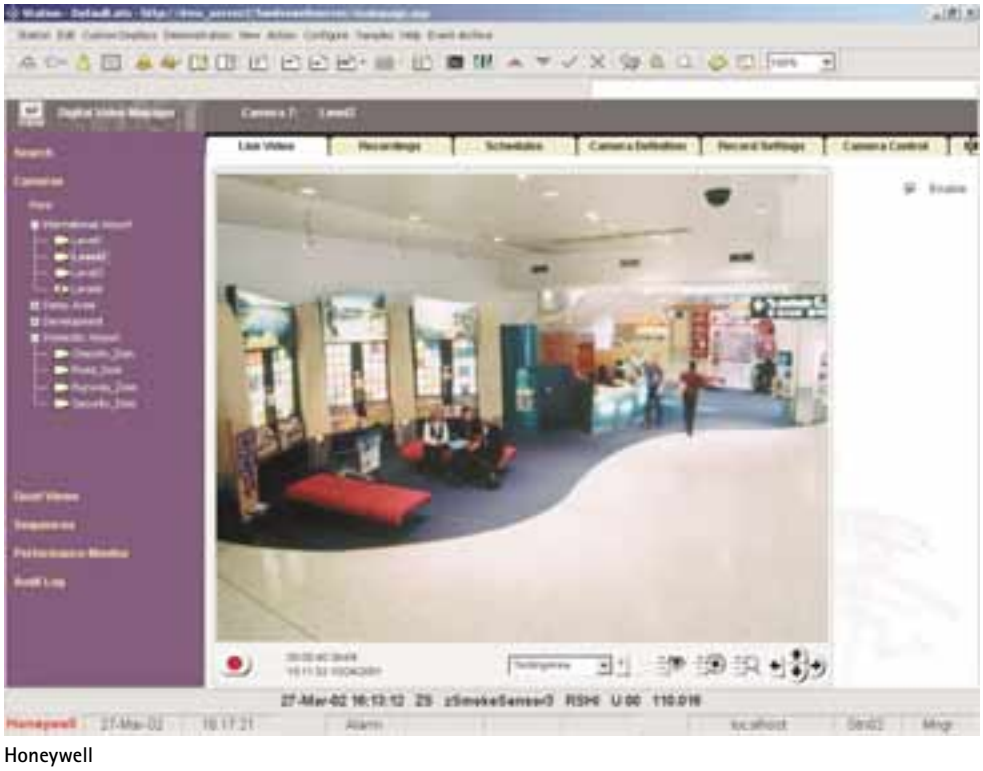
SmartConnect

Here you see SmartConnect's Digital Surveillance System deployed on the highway. Traffic services use Axis network cameras to capture and broadcast images of traffic conditions and the emergency services can use them to assess accident situations.



Milestone Systems A/S

Xprotect Business - Advanced surveillance for 1-64 cameras. High performance database, audio recording, motion detection, e-mail/SMS alerting, advanced PTZ control with presets and patrolling, I/O relay control, remote access and AVI/JPEG export. Seamless integration with Milestone Xprotect Central for monitoring 1-1000+ systems.



Honeywell

Honeywell's Digital Video Manager (DVM) is a scalable, digital CCTV surveillance solution. Integrated with Security/Building Control and Industrial Control Systems, it gives the user full view and control from Operator consoles. Includes Video Motion Detection, Control System Alarm/Event activated recordings and pre-record.

Network security

Security cameras should always be protected with a password.

A password can be used to restrict the level of access to the camera so that only specific individuals or groups have full access to the images and/or configuration pages. Most network cameras support 'anonymous user access' (by default), which means that in the absence of a password, the camera images are available to everyone with access to the network.

For high security applications, cameras should be accessed over a secure connection that employs a data encryption protocol called the Secure Sockets Layer (SSL). Both Internet Explorer and Netscape Navigator support SSL, and many Web sites use this protocol to protect confidential user information, such as credit card numbers. By convention, URLs that need an SSL connection start with https: instead of http:.

Capturing images

There are some basic rules that apply if you want to obtain high-quality images from a camera. These rules are equally applicable to network cameras as they are to any other type of camera.

The quality of the computer displaying the images is always important. It should be configured to display at least 16 bits color.

Here are some simple tips for capturing good images.

Use lots of light

The most common reason for poor quality images is a lack of light. Generally, the more light, the better the images. With too little light, the images will become blurred and dull in color. Professional photographers always use strong lamps.

Lux is the standard unit for measurement for light. The table shows how much light you can get in different kinds of conditions.

At least 200 Lux is needed to capture good quality images. A high-quality camera might be specified to work down to 1 Lux. This means you can capture an image at 1 Lux; not that you will get a good image at 1 Lux. Different manufacturers use different references when they specify the light sensitivity, which makes it hard to compare cameras without looking at captured images.

Avoid back light

Try to avoid bright areas in the images. Bright images might become over-exposed (bright white) and objects can then appear too dark. This problem typically occurs when attempting to capture an object in front of a window.

Reduce the contrast

A camera adjusts the exposure to obtain an average level of light in the image. When trying to capture an image of a person standing in front of a white wall, the person generally tends to appear too dark. This problem is easily solved by substituting the background color for gray instead of white.

Environment	Lux
Strong sunlight	100,000
Full daylight	10,000
Normal office light	500
Poorly lit room	100

Avoid very bright areas in an image by changing the camera position.

Advanced cameras include the feature to compensate for back light.

Mounting a camera outdoors

If a camera is to be mounted outdoors, you need an outdoor casing to protect it. These are available from Axis and many other surveillance suppliers. Outdoor casings come in different sizes and qualities and some versions have built-in fans for cooling and/or heaters for warming. This allows the cameras to be mounted in relatively hostile environments.

Outdoor casing suitable for use with Axis network cameras.

IR lamp suitable for use with an AXIS 2420 Network Camera - IR Sensitive.

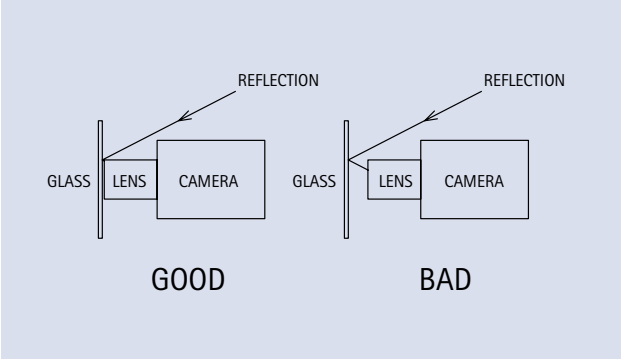
Always use auto iris lenses with outdoor cameras. They adjust the amount of light that reaches the image sensor. This will give the camera better dynamics and protect the image sensor from becoming damaged by strong sunlight.

Lighting

When using cameras at night you might need additional external lighting. This should be arranged so as to avoid any reflections and/or shadows.

For covert security, Infrared (IR) illuminators can be used instead of normal lighting. IR light is not visible to the human eye, which means that whilst it is sufficient for capturing images from IR cameras, it cannot be seen by intruders.

You can connect traditional IR-sensitive cameras to a network via a video server, or connect IR-sensitive network cameras directly. Note: Color cameras do not work with IR light. See also Infrared, on page 26.



If you mount a camera behind glass i.e. in an outdoor housing, make sure that the lens is close to the glass. If it is too far away from the glass, reflections from the camera and the background will appear in the image.

Avoid direct sunlight

Always try to avoid direct sunlight in an image. Direct sunlight will “blind” the camera and can permanently bleach the small color filters on the sensor chip to cause stripes in the image. If possible, position the camera so that it faces away from the sun.

An image from a camera where the image sensor filters have been destroyed by the sun.

When using a camera outdoors, avoid viewing too much 'sky'. Due to the contrasting light, cameras automatically adjust themselves to achieve a good light level for the sky at the expense of making the landscape/objects appear too dark. One way to avoid this problem is to mount the camera high above ground. Always use sturdy mounting equipment to avoid vibrations caused by strong winds.

Amplifier gain

In advanced cameras, the amplifier gain on the image sensor can be adjusted. The higher the gain, the better the camera's performance in low light conditions. Unfortunately, any noise within the sensor is amplified as well. Use a high gain to get the best results in low light conditions and a low gain if you want high-quality images during good light conditions. Normally this is handled automatically by the camera.

Shutter speed

In some cameras the shutter speed is determined automatically; in particularly advanced models the shutter speed can be controlled manually. Normally it should be set to 1/50 or 1/60 second; a long exposure time will give better performance in low light. If you want to capture images of fast moving objects, choose a shutter speed of e.g. 1/10 000 second.

Choosing the right lens

There are two main mounting standards. They both have a 1" thread and they look the same. If you find it impossible to focus your camera, then you probably have the wrong type of lens.

- CS-mount. The distance between the sensor and the lens should be 12.5 mm
- C-mount. The distance between the sensor and the lens should be 17.5 mm. A 5 mm spacer (C/CS adapter ring) can be used to convert a C-mount lens to a CS-mount lens

Sensor size

The lens must make an image large enough for the sensor. The larger the sensor, the more expensive the lens will be. A lens made for 1/2" will work for 1/2", 1/3" and 1/4" sensors, but not for a 2/3" sensor. If you use a lens made for a smaller sensor on a bigger sensor, the image will get black corners.

Focal length

The focal length combined with the sensor size gives the viewing angle. A small focal length gives a wide-angle view. A large focal length gives a narrow telephoto view.

Wide-angle lenses have a better depth of field than telephoto lenses. This means you can focus close up to the camera as well as at a distance. Telephoto lenses require a more precise focus adjustment.

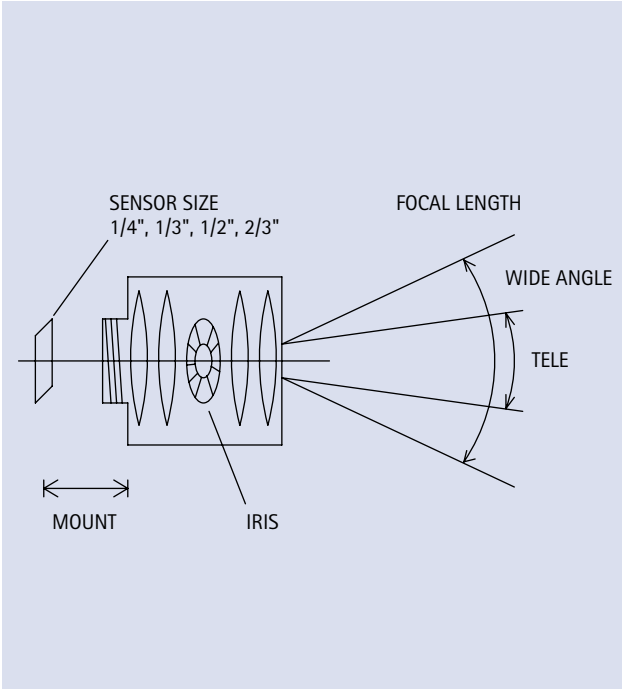
Three main types of lenses

- Mono-focal. The focal length is fixed, e.g. 4 mm
- Zoom. The focal length can be adjusted within a range, e.g. 4 to 10 mm. Focus stays when the focal length is changed
- Varifocal zoom. This is a lower cost zoom lens. When the focal length is changed, the lens has to be refocused. The most common type is 3.5-8 mm

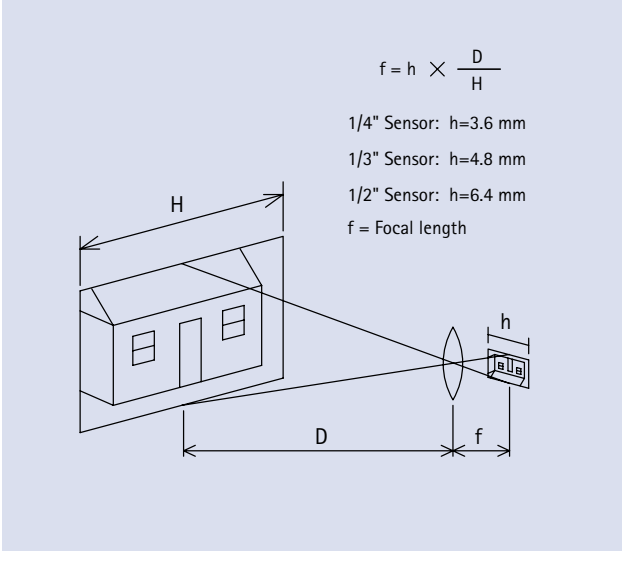
Example

What width of objects will you be able to see at 10 ft if you have a camera with a 1/4" CCD sensor and a 4 mm lens?

H = D x h / f = 10 x 3.6 /4 = 9 ft



The figure shows a schematic drawing of a lens. A lens usually has 4-10 lens elements.



Here you see the formula for calculating focal length.

Iris

The role of the iris is to adjust the amount of light passing through the lens. There are three different types of irises on lenses:

- Manual Iris. Turn a ring to adjust the iris, or use a fixed iris lens. A selection of iris apertures is available e.g. F1.4, F 2.0, etc
- DC Auto Iris. Connected to the output of a camera, the iris is steered by the camera's Digital Signal Processor (DSP)
- Video Auto Iris. The iris is steered by video signal

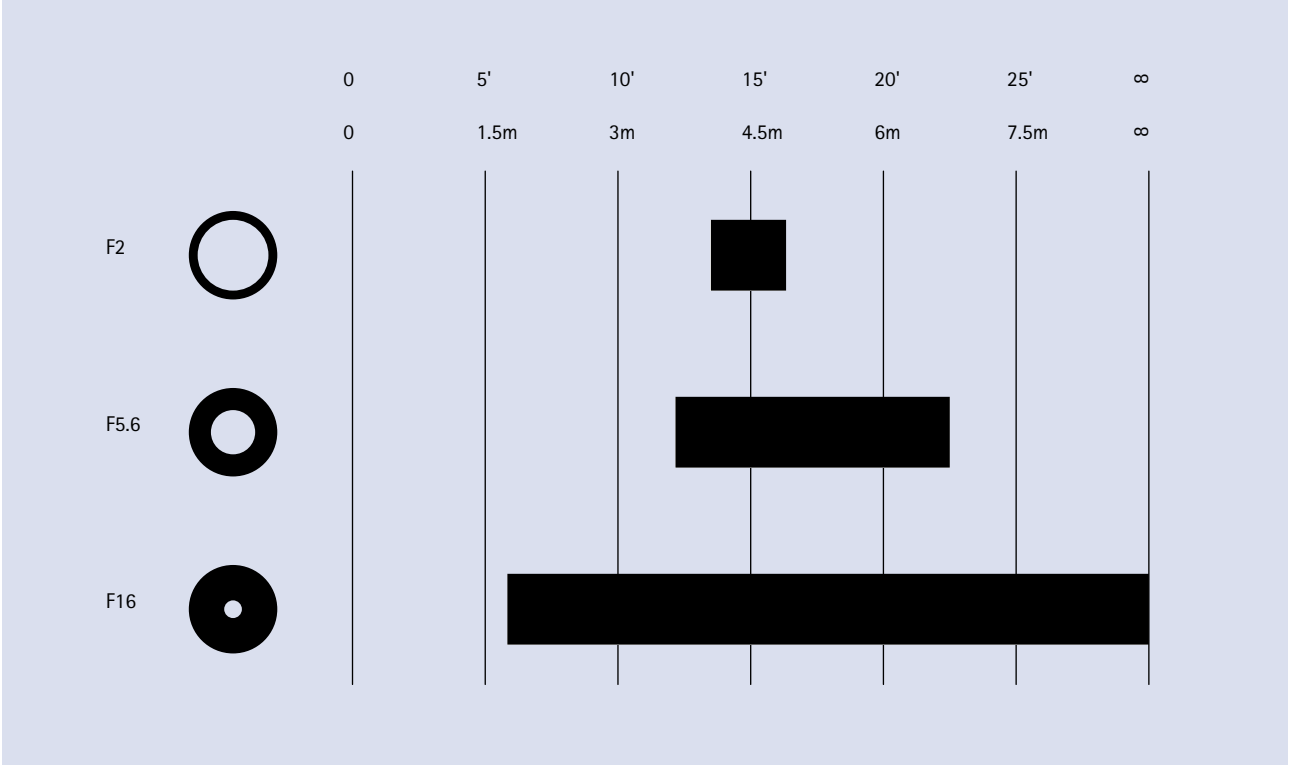
Auto iris lenses are recommended for outdoor applications. The iris automatically adjusts the amount of light reaching the camera and gives best results, as well as protecting the image sensor from too strong light.

A small iris diameter reduces the amount of light, giving a better depth of field (focus over a greater distance). A large iris diameter, on the other hand, gives better images in low light. The iris is defined by the F-number.

F-number = Focal length / Iris diameter

A lower F value gives better pictures under low light conditions.

With an auto iris lens, always set the focus in low light. If you make the adjustment in sunlight it is very easy to focus: but then at night the iris diameter increases and the image is no longer in focus. You can also get special dark filters which reduce the light e.g. 10 times. These filters are helpful when you install cameras.



This is an example of the depth of field for a telephoto lens. A large F-number gives focus over a greater distance. For typical 3.5-8 mm lenses you can focus from 10 ft/3 m to 50 ft/15 m.

Image quality

If you compare the images from different cameras you will find that the quality differs considerably between different brands. These quality variations depend on several factors and are especially noticeable in low light conditions.

Determining factors

The major factors effecting image quality for cameras can be defined as follows:

- The lens
- The optical filter
- The image sensor
- The camera's Digital Signal Processor (DSP)
- The compression standard and its implementation

Varifocal lenses

A good lens is important for achieving high image quality. Good basic lenses can be found from a few manufacturers, but note that the basic lenses sourced from these suppliers should use glass (not plastic).

Infrared

An optical filter is placed between the lens and the image sensor. Its main purpose is to remove the invisible infrared (IR) light. All image sensors are sensitive to IR light; without this filter the images tend to look very bad in some environments, e.g. in rooms lit with normal light bulbs.

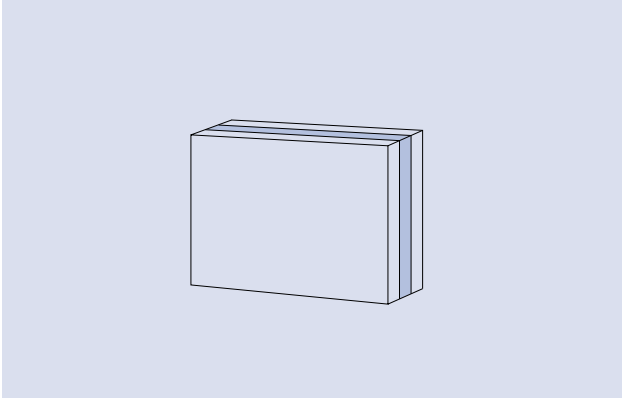
Night cameras are not fitted with this filter as it reduces sensitivity. The filter is invariably a piece of glass, but it may also be built into the lens.

In more expensive cameras an optical low pass filter is added. These reduce the amount of false color that can occur when the scene contains 'thin' details.

Image sensors

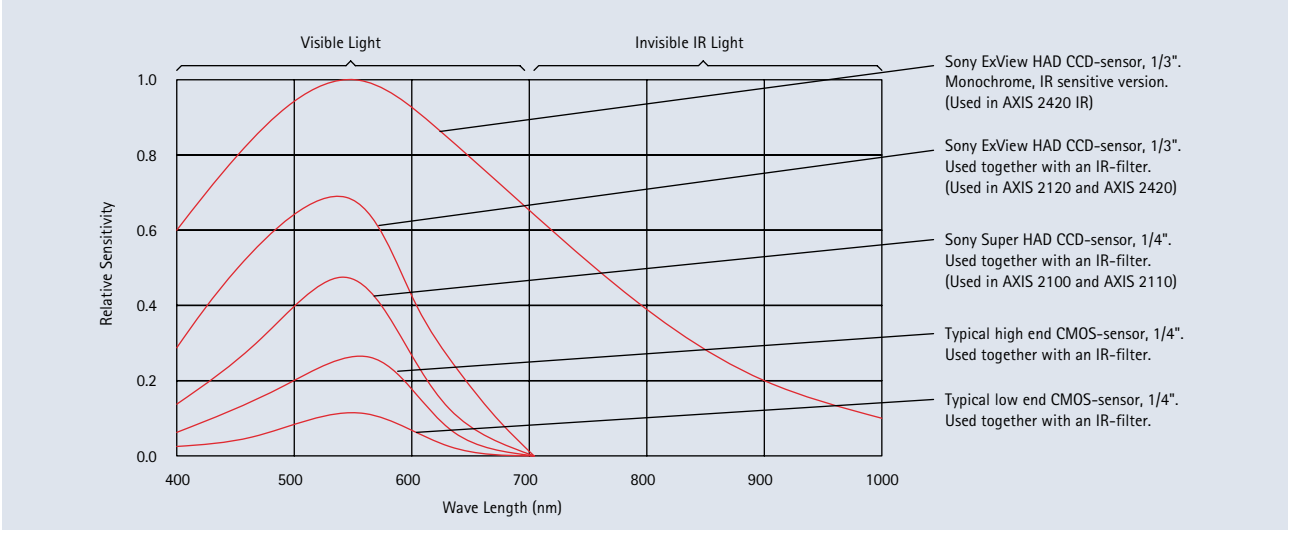
Two main image sensor technologies are currently available: CCDs and CMOS-sensors. CCDs are more sensitive in low light conditions and give better dynamics than CMOS-sensors. CMOS-sensors, on the other hand, provide alternative camera solutions that are both smaller and cheaper.

A high quality vari-focal lens.



An optical IR filter.

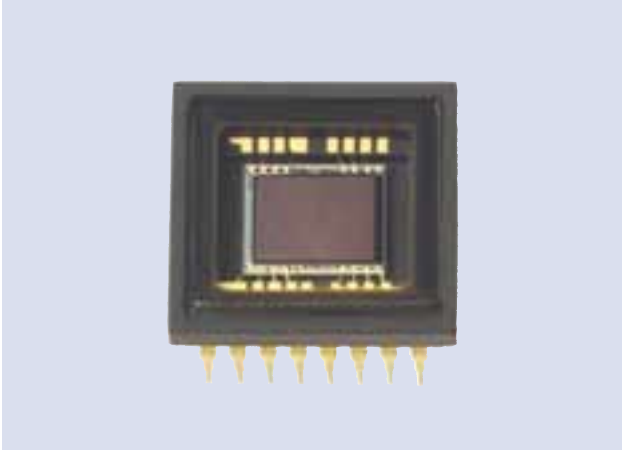
A basic mono focal lens.



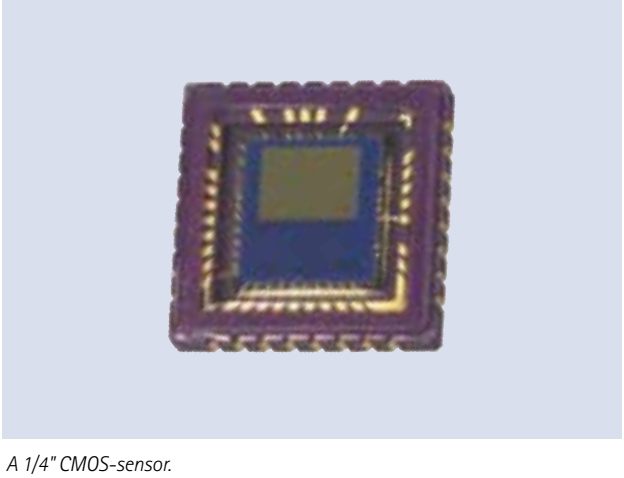
Comparison chart displaying the relative sensitivity and wavelength for different sensors. Generally, black and white sensors are more sensitive than color sensors; CCDs are more sensitive than CMOS-sensors.

The raw image data from an image sensor must be processed in order to achieve a good image, i.e. the color must be trimmed, the edges must be sharpened, the exposure must be controlled, and the white balance must be adjusted. These functions are all driven by the Digital Signal Processor (DSP).

The image compression should be made in hardware to achieve a high frame rate. It is important that the compression is made without losing the color levels and the details in the images.



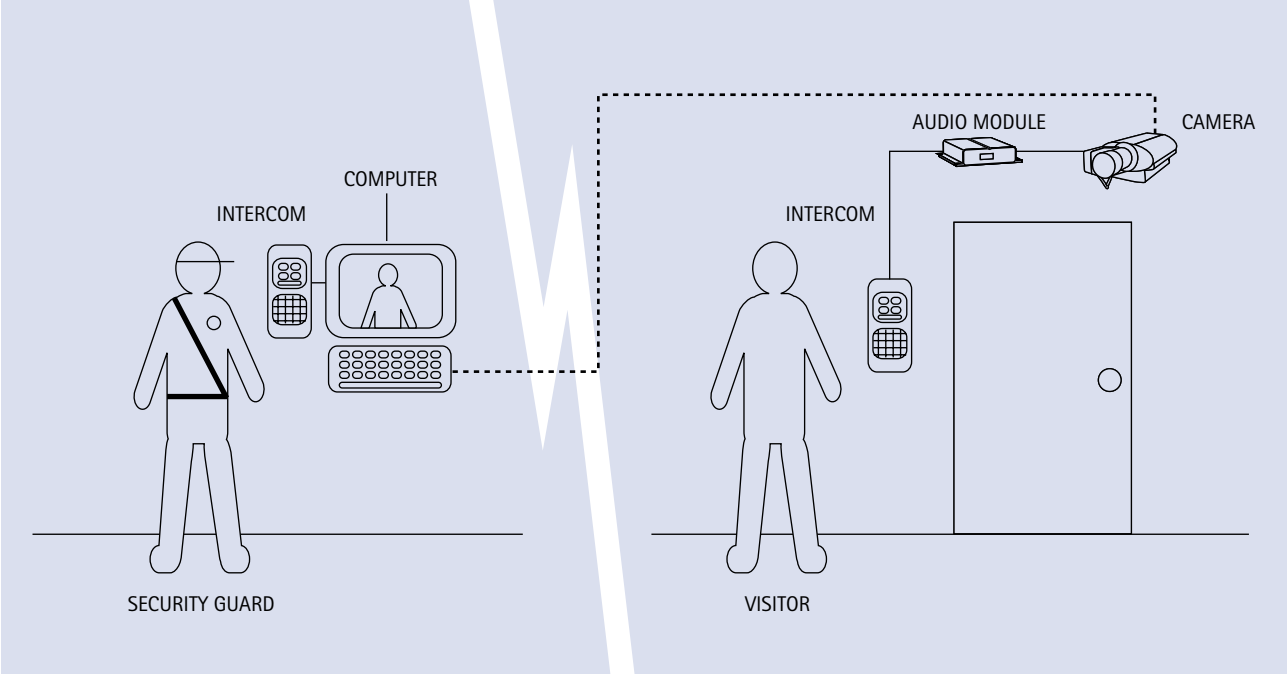
A 1/3" CCD.



A 1/4" CMOS-sensor.

Audio

Audio can normally be added to the video when using network cameras or video servers. The audio capability is either built into the network camera/ server, or is supplied as an accessory. It can be either simplex (one way), or duplex (two-way) and provides a good solution for many reception points, remote guidance and remote meeting applications.



An AXIS 2120 Network Camera connected to an AXIS 2191 Audio Module.

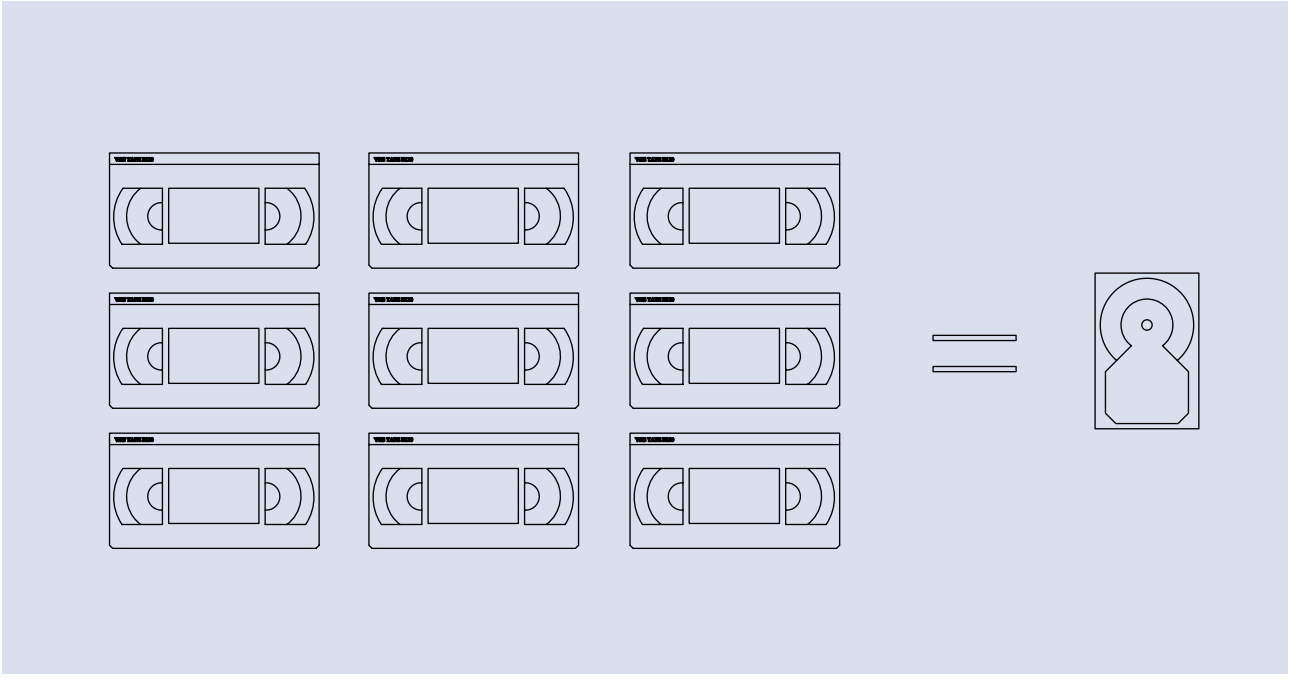
Hi-fi audio is included in the standards for MPEG-1/ MPEG-2/MPEG-4. This means you can get high-quality stereo sound synchronized with the video.
NB. The audio is not synchronized with the images when using still image standards.

The simplest kind of digital audio is created by sampling and converting the analog audio signal into digital form. The amount of data can be reduced by approx. 50% if you use a logarithmic representation. This principle is used by the audio standard G.711 that is implemented in the AXIS 2191 Audio Module. Further data reductions are achievable by simply sending the difference between the two measurements, subsequently using less bandwidth. This principle is used in e.g. G.721.

More advanced compression methods use e.g. mathematical transformations and/or pattern recognition. These methods are very efficient, but as they compress many samples at the same time, the signal gets delayed. Generally speaking, the more efficient the compression, the longer the delays will be.

Storage and transmission

Images can be stored and transmitted by analog or digital means. Traditional analog video cameras transmit images over a coax cable and store them on magnetic tape. Although this works well in many cases, the image quality is lower when the video signal is transmitted over long cable distances. The resolution of a magnetic tape can also be quite low. By comparison, digital images never lose quality during transmission or storage.



One 120 GB hard disk can store 4,8 million still images. This is equivalent to 9 VHS tapes (E180).

The size of digital images is measured in kilo Bytes. Digital images can be stored on a computer hard disk, the capacity for which is measured in Giga Bytes. Several million digital images can be stored onto a single hard disk. When the hard disk is full, the old images can be erased automatically to make space for new ones. Network video products effectively eliminate the job of switching tapes.

1 kB (kilo Bytes) ~ 1,000 Bytes
1 MB (Mega Byte) ~ 1,000,000 Bytes
1 GB (Giga Byte) ~ 1,000,000,000 Bytes
1 TB (Tera Byte) ~ 1,000,000,000,000 Bytes

Example
One image per second, 24 hours per day for almost two months can be stored on one 120 GB hard disk. Each image will be of much higher quality than an image from a VHS tape.

A typical size of a high-quality image is 25 KB
A typical size of a hard disk is 120 GB
120,000,000,000 Bytes / 25,000 Bytes = 4,800,000
4,800,000 / 60 sec. / 60 min. / 24 h = 55 days

Resolution

The resolution of analog cameras is often measured in horizontal TV lines. The resolution of digital cameras is measured in pixels on the sensor (the CCD chip).

Conversion examples

The table below shows the approximate number of horizontal lines for different image resolutions:

512x492 pixel = 330 Horizontal TV lines
512x582 pixel = 330 Horizontal TV lines
640x480 pixel = 400 Horizontal TV lines
768x492 pixel = 470 Horizontal TV lines
768x582 pixel = 470 Horizontal TV lines
1280x960 pixel = 800 Horizontal TV lines

When using digital images it is possible to select the desired image quality. Remember, the higher the quality of the images, the greater the amount of data. And images containing a lot of data take longer to transmit and take up more space on a computer hard disk.

With the exception of scientific applications, images are always compressed to reduce the amount of data. As a rule of thumb, you can usually reduce the amount of data by a factor of 10 without any reduction in the quality of the image.

The amount of data in an image – some basic principles

- Large images require more data than small images
- Highly compressed images require less data than images using low compression

NB. The higher the compression, the more blurred the images.

- Scenes with a lot of detail generate more data than scenes with little detail. For example: an image of a colorful tree will generate significantly more data than an image of a plain-colored wall

Examples of JPEG images with varying levels of detail. The branches of trees consist of a large amount of detail, which generate a large amount of data.

Not very detailed, file size 20 kB.

Very detailed, file size 50 kB.

Examples of JPEG images taken using different compression ratios. The images have been captured with an AXIS 2120 Network Camera, using a resolution of 704x576 pixels.

Low compression, file size 45 kB.

Detail of image on left.

Medium compression, file size 27 kB.

Detail of image on left.

High compression, file size 14 kB.

Detail of image on left.

Compression standards

Digital images and digital video are always compressed in order to save space on hard disks and to speed up transmission. Usually the compression ratio is 10-100. An uncompressed image with a resolution of 640x480 pixels is approximately 600 kB (2 bytes per pixel). Compressed 25 times the image file size will be approximately 25 kB.

Many compression standards to choose from

Cameras using still image standards send single images over the network. Cameras using video standards send still images mixed with data containing the changes. This way, non-changing data, like the background, is not sent in every image. Video standards also include audio in the data stream. The image refresh rate is referred to as frames per second, or fps for short.

Main differences between still image and video compression

- Still image compression is simple and easy to work with
- It is difficult to obtain a single image from a video stream using video compression
- Video compressions use less data to store/transmit a video sequence
- It is not possible to reduce the frame rate when using video compression
- Still image compression is more suitable when using a modem, or other media that can only offer narrow bandwidth

With the exception of Motion-JPEG, all video compression standards mix still images with partially complete images. By storing only the changes from one full image to another, these 'partially complete' images reduce the file size of the compressed video sequence. Scenes containing little or no variation can be compressed quite dramatically.

NB. When using Pan, Tilt and/or Zoom camera functions large image variations can occur as the result of sudden camera movement.

Compression standards for still images

JPEG

This is short for Joint Photographic Experts Group international – a good and very popular standard for still images that is supported by many modern programs. Conforming to ISO/IEC 10918, this is the preferred compression standard for many network cameras.

Each image is divided into 8x8 pixels. Each block is then individually compressed using the Digital Cosine Transform (DCT). If a very high compression ratio is used, the 8x8 pixel blocks can actually be seen in the image.

Wavelet

This standard is optimized for images containing low amounts of data. Consequently, the images are not of the highest quality. Wavelet is not standardized and requires special software for viewing.

JPEG 2000

Based on Wavelet (and not JPEG) technology, this is a new and still relatively little-used standard.

GIF

This is short for Graphics Interchange Format - a bit-mapped graphics file format used widely on the Web. Limited to 256 colors, it is a good standard for images that are not too complex, e.g. scanned images and logo-types. It is not recommended for network cameras as the compression ratio is too limited.

Compressed using JPEG

Compressed using H.261

The image of a moving person will become like a mosaic if H-series compression is used. The normally uninteresting background will however retain its good and clear image quality.

Compression standards for video

Motion JPEG
With motion JPEG, each frame within the video is stored as a complete image in the JPEG format. The still images are displayed at a high frame rate to produce very high-quality video, but at the cost of producing comparatively large file sizes.

H.261, 263, 321, 324 etc.
These refer to the standards recommended by the International Telecommunications Union (ITU). Designed for video conferencing, but sometimes used for network cameras, these standards offer a high frame rate. However, they produce a very low image quality, usually with image resolutions up to 352x288 pixels. As the available resolution is quite limiting, newer products tend not to use this standard.

MPEG 1
Moving Picture Encoding Group international standard ISO/IEC 11172.

There are numerous possible variations of this format, but normally the Constraint Parameters Bitstream, CPB standard is used, giving 'VCR quality'. This gives a performance of up to 352x288 pixel, 30 fps, max 1.86 Mbit/s.

Audio according to MPEG 1 layer 1, 2 and 3 are included in the standard. (MPEG 1 layer 3 audio is often called MP3.)

Video CDs use the MPEG 1 format at a bit rate of 1.2 Mbit/s.

As the available resolution is quite limiting, newer products tend to use MPEG 2 instead.

MPEG 2
Moving Picture Encoding Group international standard ISO/IEC 13818. A popular standard that offers high-quality video suitable for installations where TV-quality is needed. There are numerous possible variations of this format but normally the Main Profile at Main Level, MP@ML standard is used to provide a resolution of 720x480 pixels at 30 fps (NTSC) or 720x576, 25 fps (PAL). The bit rate is typically 1-10 Mbit/s. An MPEG 2 player can display either MPEG 1 or MPEG 2 formats.

Audio conforming to AC3, AAC and MPEG 1 layer 1, 2, 3 standards are included in this format. (MPEG-1 layer 3 audio is often called MP3.)

DVD-films and digital cable TV use MPEG 2 with a bit rate of approx. 5 Mbit/s.

MPEG 3
A cancelled standard aimed at HDTV (High Definition TV).

MPEG 4
Moving Picture Encoding Group international standard ISO/IEC 14496. This standard covers a wide variety of applications ranging from the video displayed in cellular phones, to full feature-length movies shown in a cinema. MPEG 4 is widely tipped to be the video standard of the future but it is still relatively new and not widely used.

This format contains many enhancements to any of the early MPEG standards; for example, it offers narrower bandwidth and can mix video with text, graphics and 2-D and 3-D animation layers. Although these new enhancements pack the video in a very efficient manner, a lot of computing power is needed to use them in real time. It therefore requires a substantial capital investment in more powerful computers.

NB. Several network video products use low-quality compression technique (e.g. H.263) packed as MPEG 4. Study the video quality, and the available MPEG 4 applications carefully before choosing this standard. Today the MPEG 4 standard gives no benefit to the user compared to MPEG 2.

MPEG 7 and 21

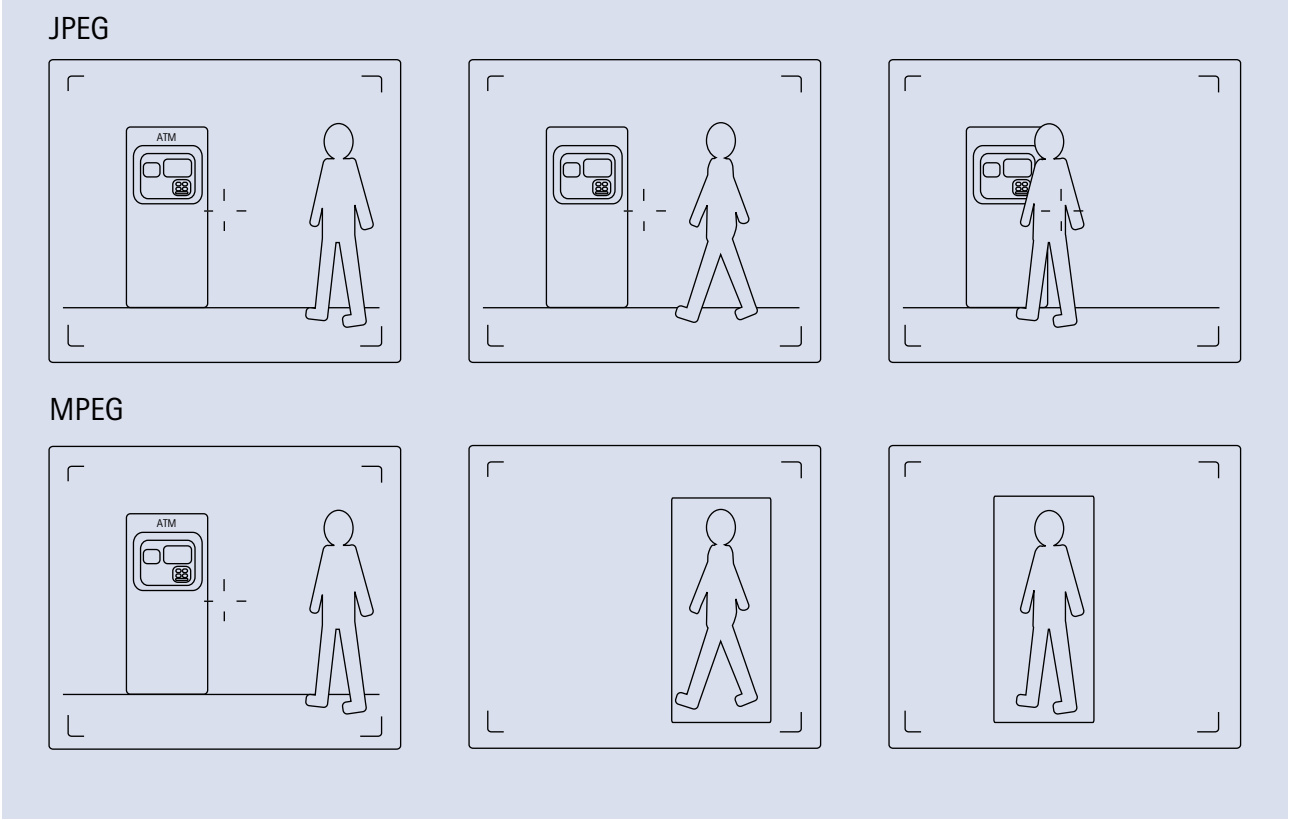
Standards for other high-level multimedia (not video).

Proprietary standards

In addition to the recognized official standards, numerous other proprietary standards have been developed and are used by different video equipment manufacturers. In the interests of future maintenance and integration, it is highly recommended that you avoid these and use only documented and widely-used open standards.

SO, WHICH VIDEO COMPRESSION STANDARD IS THE BEST?

Motion JPEG and MPEG 2 are two formats that are highly recommended. They are well-known, widely-used, international standards that offer high-quality video.



All video compression standards, except Motion-JPEG, use the technique of mixing still images with images just containing differences from other images. This reduces the amount of data when the main part of the scene is constant.

Digital transmission

IP-based video can be transmitted almost anywhere. It is not limited to any particular media and is currently in common use over switched 10 Mbit, 100 Mbit or 1 Gbit LAN, WLAN, ISDN, PSTN, PHS, CDCP and GSM networks. The developer's choice of transmission medium can be completely steered by the type of application that is being developed.

Within buildings, a 100 Mbit Ethernet network is ideal. It is fast and, due to its popularity, relatively cheap.

100 Mbit Ethernet is normally transmitted using twisted-pair copper cables. The cables can be shielded against noise. The maximum cable length should not exceed 330 ft. (100 m), although most computer stores can offer a variety of accessories for longer transmission distances, e.g. fiber optic transmitters, wireless (radio) LANs, etc..

Transmission speeds are measured in bits per second, 8 bits making up one byte. To transmit one byte, approximately two extra bits are needed for control. This means that approximately 10 bits are required to transmit one byte.

1 byte/s ~10 bit/s
1 kbit/s ~1,000 bit/s
1 Mbit/s ~1,000 kbit/s
Bandwidth (kbit/s) = File size (kB) x Frame rate (fps) x 10

The rest of this chapter is dedicated to describing the many different kinds of transmission methods to connect to networks.

PSTN and standard telephone modems

Modems are widely used for accessing the 'outside world' over the Public Switched Telephone Network (PSTN). They are cheap and practical, but have the disadvantages of being slow and experiencing frequent transmission errors.

The maximum speed for downloading files via a modem can be as fast as 56 kbit/s, the maximum speed for uploading files is significantly slower at 33.6 kbit/s.

You can connect directly from a PC to a remote network camera via standard modems using the Point-to-Point communications protocol. This protocol is supported in Windows Dial-up connections and is included in most of today's popular operating systems.

ISDN telephone modems

ISDN (Integrated Services Digital Network) is a popular communications standard for sending voice, video, and data over digital telephone lines or normal telephone wires. ISDN telephone modems are popular in many countries and are normally provided by the subscriber's telephone company. ISDN modems transmit data at a maximum speed of 128 kbit/s over 2 (64 kbit) channels.

xDSL modems

With many different varieties of xDSL transmission services now available from most telephone companies and ISPs (Internet Service Providers), ADSL, HDSL, IDSL, and VDSL modems are becoming more and more popular. By paying a fixed monthly fee, you can spend as much time on-line as you want. The speed will vary from company to company and from standard to standard, so check this with your local companies.

NB. The speed differs for uploading and downloading. Usually the download speed will be about 1 Mbit/s and the upload speed will be about 250 kbit/s.

Cable TV modems

Cable TV modems transmit data over the very same cabling used for sending their TV signals. The transmission speed for these types of modems vary from one location to another and depends on how many people in the neighborhood are using the service simultaneously. A typical maximum speed is 1 Mbit/s.

T1 connection

Sometimes referred to as a 'DS1 line', a T1 connection is a dedicated phone line that supports data rates up to 1.544 Mbit/sec. For a fixed fee every month, you can connect to the Internet for as long as you want. This standard is particularly popular among large companies.

10 Mbit Ethernet

Used within office buildings, this is a network architecture that supports data transfer rates of up to 10 Mbit/s. There are two main standards for this type of network: 10 BaseT, which uses twisted pair cables, and 10 Base2, which uses coaxial cables. 10 Base2 is not particularly popular as it can be unreliable. If there is a break anywhere in the coaxial cable, the whole network stops working. Due to frequent data collisions only about 50% of the full 10 Mbps network capacity is normally available. The use of switches eliminates these collisions to allow full utilization of the network.

100 Mbit Ethernet

This network architecture supports data transfer rates of up to 100 Mbit/s and the main standard is called 100 BaseT. Although newer and faster than 10 Mbit Ethernet, in all other respects it is the same.

1000 Mbit Ethernet, Gigabit Ethernet

This is expected to become the most commonly used system for large companies in the future. Today, however, this more recent version of Ethernet is most often used for backbones in buildings. The main standard is called 1000 BaseT.

Cellular phone modems, e.g. GSM, GPRS, CDMA, CDPD, TDMA

Using cellular phone modems is a good way to access remote cameras, e.g. cameras for traffic monitoring. No telephone cables are needed. The transmission speed is low, but sufficient for still images. Typical communication speeds range from 5-20 kbit/s. You can connect directly from a PC to a remote camera, using a standard modem for the computer and a radio modem for the network camera.

Wireless network, e.g. IEEE 802.11b

Cabling often represents the biggest cost in an installation, which is why radio networks without cabling, are becoming increasingly popular.

IEEE 802.11b, also known as wireless Ethernet or WLAN, is designed to help network engineers implement totally wireless networks.

802.11b uses direct sequence spread spectrum technology over the 2.4 GHz ISM band providing 11 Mbps communications speed without line-of-sight requirements.

802.11b supports ranges of up to 300 meters in the open air and 50-100 meters in office environments. 802.11b is also referred to as Wi-Fi.

Bluetooth wireless networks

Bluetooth is an increasingly popular short-range radio technology. Bluetooth is a low-cost, low power-consumption standard, which allows multiple mobile devices to communicate with each other wirelessly. Bluetooth uses frequency-hopping technology over the 2.4 GHz ISM band providing up to 723 kpbs communications speed without line-of-sight requirements. Bluetooth supports ranges of up to 10 meters client-to-client in open air and 5 meters in-doors with the low-power version. Due to low bandwith, Bluetooth is not suitable for video.

Power Over LAN

Now with Power over LAN it is possible to carry power to the camera on the same cable as that used for network connection. This is especially suited for IP Surveillance and remote monitoring applications - to reach places that were previously thought of as impractical or too expensive to connect to a power outlet.

Proprietary Power over LAN products have been around for a few years. They have primarily been used to power IP phones and wireless access points.

The Power over LAN Midspan connects to an existing Ethernet or Fast Ethernet infrastructure via any standard Category 5 cabling. By sending -48 V over 100 meters, Ethernet terminals can be powered by the Midspan. The Midspan is fully compatible with IEEE 802.3 standard (when no inline power is supplied). It is also IEEE 802.3af compliant, enabling compatibility with PoE products.

The Power over LAN Active Splitter means that current Network Video Products can receive power over the network by splitting Ethernet and Power coming over the network cable from the Power over LAN Midspan.

Another benefit of Axis Power over LAN solution is the UPS function. Many companies have their network switches connected to a UPS (Uninterrupted Power Supply) device. Since the Power over Ethernet hubs are connected to the network switches, the cameras and video servers continue to function in the case of a power shortage. Power over LAN is also referred to as Power over Ethernet.

Power over LAN Midspan.

Transmission type		Typical download speed	Time to transmit a 25 kbyte image (in seconds)	Max frame rate if every image is 25 kbyte (in fps)
Transmission to a house or a building	PSTN	45 kbit/s	6	10 frames/minute
	ISDN	120 kbit/s	2	0.5
	IDSL	150 kbit/s	2	0.6
	ADSL - Low end	768 kbit/s	0.3	3
	ADSL - High end	5 Mbit/s	0.05	20
	HDSL	1.5 Mbit/s	0.2	6
	VDSL	20 Mbit/s	0.01	80
	Cable modem	750 kbit/s	0.3	3
	T1	1.5 Mbit/s	0.2	6
Transmission within a house or a building	10 BaseT	5 Mbit/s	0.05	20
	100 BaseT	50 Mbit/s	0.005	200
	1000 BaseT	500 Mbit/s	0.0005	2000
Wireless radio transmission	GSM	9 kbit/s	30	2 frames/minute
	802.11	1 Mbit/s	0.2	4
	Bluetooth	500 kbit/s	0.5	2

This table shows the normal capacity of different transmission types. Note that the data is approximate and can therefore only serve as a rough guide.

IP networks

IP is the most common computer communication protocol today. It is the base protocol used for Internet, e-mail and almost every newly installed network. One of the reasons for its popularity is its scalability. In other words, it works equally well in very small installations as it does in very large installations and is supported by an increasingly wide range of high-performance, low-cost equipment.

In a modern office, computers are most likely to be connected through Ethernet, via a Local Area Network (LAN), or a Wireless LAN. Ethernet gives a fast network at a reasonable cost. All modern computers are supplied with an Ethernet connection or can easily accommodate an Ethernet connection card. If you install an Internet connection today (cable modem, xDSL, etc.) it will probably have an Ethernet connector.

Ethernet is available over fixed or wireless networks and is available in three different speeds: 10 Mbit/s, 100 Mbit/s and 1,000 Mbit/s. For home and small office use 100 Mbit/s is recommended.

This chapter contains basic information about Ethernet network components and their relative protocols.

This switch is manufactured by Cisco. Other major manufacturers include D-Link and 3com.

Hubs, switches and routers

Hubs are essentially used as connection boxes to allow several pieces of equipment to share a single Ethernet connection. Usually 5-24 devices can be connected to one hub. If more devices are used, another hub can be added.

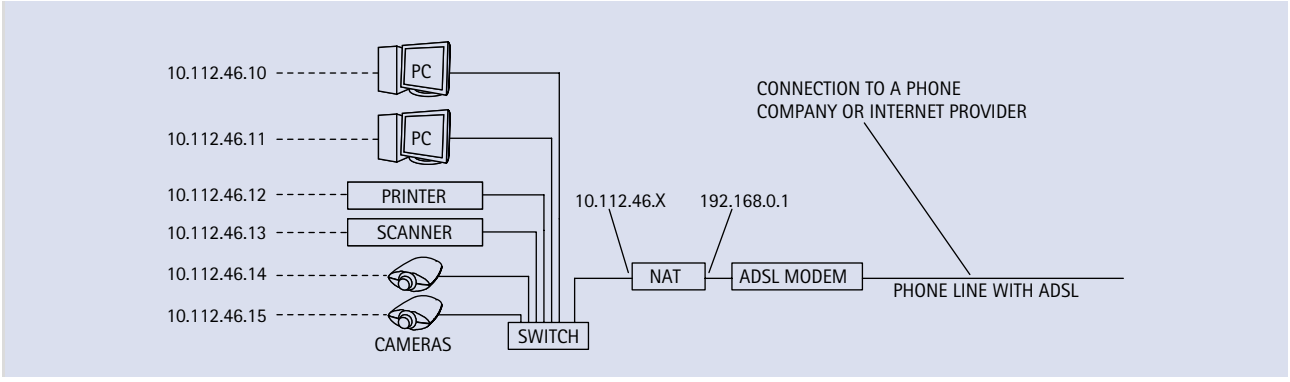
To speed up the network, you can use switched hubs, switches or routers that allow several data packets to be transmitted simultaneously. Although they are somewhat more expensive than normal hubs, switches provide much better capacity and are generally recommended. Switches can interface between 10, 100 and 1,000 Mbps.

Example

You want to record images from six network cameras connected to a server placed in a room 200 meters away. Instead of using cables from each camera with 200 meters of cables (1.2 km cables in total), you could use a hub or a switch, which interconnects the cameras and only need one 200 meter cable. The cable used for these kinds of connections, CAT-5, is also cheaper than the coax cable used in analog installations. And since the installation using a hub or a switch requires less cabling, the overall cost will be kept to a minimum. This is a huge advantage for IP network video systems compared to analog technology.

Bridges

If more than 255 devices are connected to the same network, the network needs to be divided into segments. A router must be placed between segments. Alternatively, a bridge can be used. Switches sometimes have built-in router functions. For example, an airport with two buildings using 170 cameras each needs to be connected to the same security central several kilometers away. To have access to all cameras simultaneously, you simply divide the cameras into two networks and connect them together with a bridge.



A typical network set up within a small office using ADSL connection to Internet. The NAT working as a router makes it possible to separate the LAN from the Internet.

IP addresses

Each device on a LAN (Local Area Network) must have a unique address. This is commonly called the 'IP address', and is occasionally referred to as the Ethernet address. An IP address consists of four numbers separated by a dot ' . ', each number is in the range 0-255. For example, the address could be 192.36.253.80.

The first three groups of digits will be common to all devices connected to the same segment, i.e. in the previous example, all units within the same segment will have a common address beginning with 192.36.253.

Each IP address is divided into 65,535 ports. Different applications use different IP ports. HTTP (ordinary Web browsing) usually uses port 80 (e.g. 192.36.253.80:80). Normally users do not need to concern themselves with port numbers.

Data packets

All data is sent within a data packet, and all packets are labeled with the address of the destination. In an Ethernet network a packet is transmitted approximately every 0.1 milliseconds. This means that up to 10,000 packets can be transmitted every second.

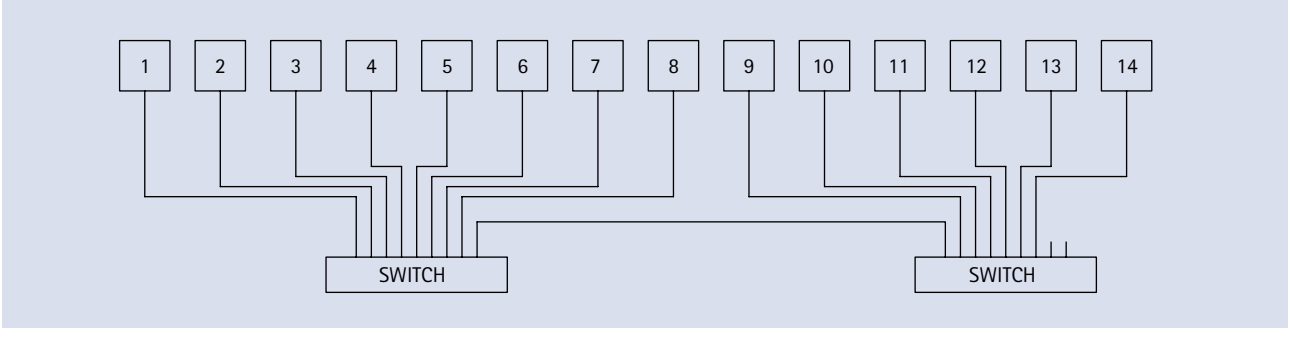
As modern computers and network devices have a high capacity, they can communicate simultaneously with several units. A modern network camera can send images to at least five computers simultaneously.

NAT routers

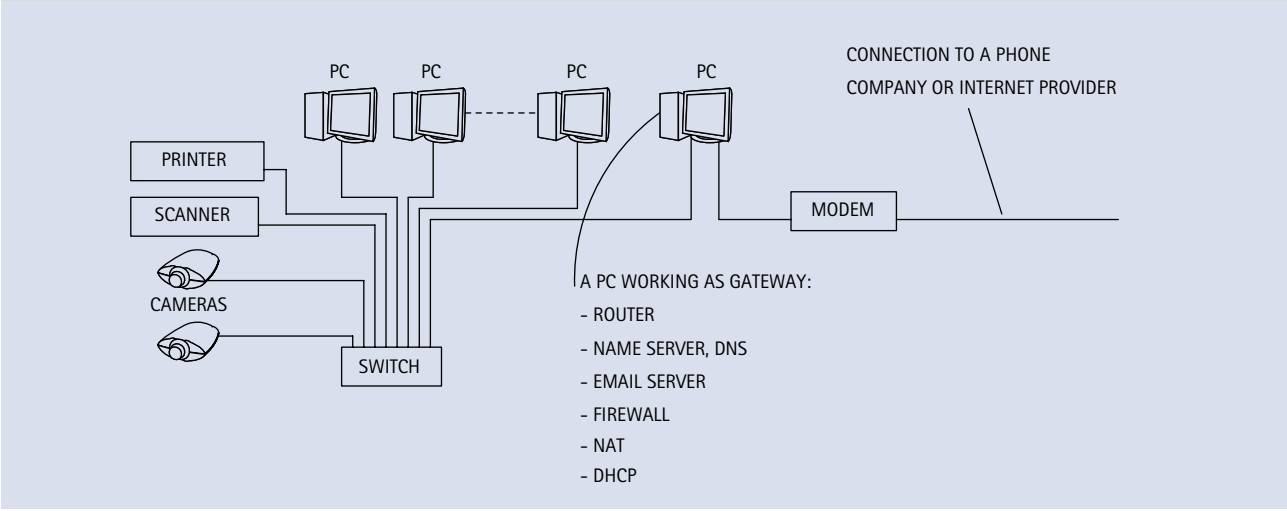
All devices connecting directly to the Internet must have a unique public IP address. Public IP addresses are sold by Internet Service Providers (ISP's). A device called a Network Address Translator, NAT, can separate a LAN net from the Internet. A NAT can either be a small box or a program running on a computer. Most office LANs are normally connected to the Internet to make it possible to send e-mails and to browse the Internet. This connection is normally made via a modem.

Gateways

Gateways provide a convenient way to create a local network. A gateway works as a combined router, switch and NAT and is available from various manufacturers, for example Cisco, D-Link and 3Com.



Example of an Ethernet network with 14 devices. The devices can be PCs, printers, network cameras or any other piece of equipment with an Ethernet connector. In this example the switches have 9 connectors each. Two more devices can easily be added. To add more than two, another switch would be needed.



An example of a typical office using a PC as the gateway to the Internet. The PC functions as a router with two IP addresses: one relevant to the internal network, the other one for its use over the Internet.

DHCP servers

It takes time to administer the IP addresses for large numbers of devices on a network. To reduce this administration time and keep the number of IP addresses to a minimum, you can use a device called a DHCP server. This type of server automatically issues network devices with IP addresses when they connect to the network.

Domain Name Servers

In larger networks a Domain Name Server (DNS) is included. This is literally a 'name' server; it associates and remembers given names to corresponding IP addresses. For example, a network camera monitoring a door is more easily remembered and accessed by the word 'door' than it is by its IP address, e.g. 192.36.253.80.

Firewalls

All networks connecting to the Internet should be protected against hackers. An Internet 'firewall' is a device that ensures that only authorized users can access devices connected to the LAN.

In larger networks it is common to use a PC to perform the combined functions of a NAT, DHCP server and firewall. This PC may also be used as an e-mail server, name server, and image storage.

Internet connection with Web space

Obtain an Internet connection that includes space on a Web server. The cameras can then be programmed to continuously update images on the Web server.

Internet connection with remote modem

Install a modem in the office. This makes it possible to access the company network from home via a modem. This is a common solution, used by many people working from home.

Internet connection with VPN or SSH software

Obtain an Internet connection that includes a single public IP address and install software VPN (Virtual Private Network) or SSH (Secure Shell) software on a gateway computer. Although this is a safe way to access the company network over the Internet, you will need a good knowledge about networks to implement and maintain it.

Internet connection with firewall and NAT

Obtain an Internet connection with one public IP address and configure the firewall/NAT so that different port numbers are 'mapped' (assigned) to the respective IP addresses of the cameras; for example, www.name.com: 8080 will access the LAN IP address 10.112.46.14. You will also need a good knowledge about networks to implement and maintain this solution.

Internet connection with continuous camera upload

Obtain an Internet connection with a single public IP address. Add a Web server and program the cameras to continuously update this Web server. You will also need a good knowledge about networks to implement and maintain this solution.

Network video products from Axis

Axis offers a comprehensive range of network camera and video server products. For more information, please contact an Axis distributor, or visit the Axis Web site at www.axis.com where you will find datasheets, user documentation, and a variety of application examples.

AXIS 2100 Network Camera

- Indoor network camera
- High-quality JPEG images
- CCD sensor technology
- Resolution 640x480 pixel
- 4 mm standard CS mount lens included
- Mounting bracket included
- Frame rate 10 fps (320x240)
- 3-10.000 Lux
- In order to increase light sensitivity, the frame rate is automatically reduced in low light

AXIS 2110 Network Camera

- Indoor/outdoor network camera
- High-quality JPEG images
- CCD sensor technology
- Resolution 640x480 pixel
- 3.5-8 mm vari-focal CS mount manual iris lens included
- Mounting bracket included
- Frame rate 15 fps (320x240)
- 1-200,000 Lux
- In order to increase light sensitivity, the frame rate is automatically reduced in low light

AXIS 2120 Network Camera

- Indoor/outdoor network camera
- High-quality JPEG images
- Exview CCD sensor technology
- Resolution 704x480 (NTSC, 60 Hz), 704x576 (PAL, 50 Hz)
- Standard CS lens fitting.
- High-quality 3.5-8 mm vari-focal DC Auto iris lens included
- Mounting bracket included
- Frame rate 30 fps (NTSC, 320x240), 25 fps (PAL, 352x288)
- Excellent in low and strong lighting conditions (1-200.000 Lux)
- Built-in motion detection

AXIS 2130 Network Camera

- All in one integrated Pan/Tilt/Zoom camera solution
- Auto focus for ease of use and quick access to the objects
- 16x optical zoom
- High quality JPEG image
- Resolution 704x480 pixel
- Frame rate 30 fps
- Desk and ceiling mounted version available

AXIS 2420 Network Camera

- Indoor/outdoor network camera
- High quality color JPEG image
- Exview HAD CCD sensor technology
- Resolution 704x480 (NTSC, 60 Hz), 704x576 (PAL, 50 Hz)
- 2.8-12 mm vari-focal DC iris lens optional
- Frame rate 30 fps (NTSC, 320x246), 25 fps (PAL, 352x288)
- Excellent in low and strong lighting conditions (1-200.000 Lux)
- Built-in motion detection
- RS485/422 port for pan/tilt control
- Analog video output
- Also available in black/white IR sensitive version (0,5-200.000 Lux)

The AXIS 2420 Network Camera has both analog video output and IP network connection. This means it can be integrated into traditional CCTV systems as well as into networked video systems.

AXIS 250S MPEG-2 Video Server

- For professional applications demanding bandwidth efficient video
- High-resolution (720x576) DVD-standard MPEG-2 video stream
- CD-quality synchronized stereo sound
- Up to 1 minute of pre-alarm video buffer
- Independent system with embedded Web server
- Real-time MPEG-2 hardware compression and transmission
- High performance: capable of data rates up to 8 Mbit/s and full frame rate of up to 60 fields per second per user
- Minimum bandwidth 250 kbit/s
- Support for pan/tilt/zoom cameras

AXIS 2400+ Video Server

- Accommodates up to 4 video sources using 4 video decoders for fast switching
- High-quality JPEG images (quality is dependent upon the analog video source)
- Resolution 720x480 (NTSC), 720x576 (PAL)
- Frame rate 30 fps (NTSC, 352x240), 25 fps (PAL, 352x288)
- RS 485/422 port for pan/tilt control
- 4 alarm inputs, 1 output
- Supports PAL and NTSC video sources

AXIS 2401+ Video Server

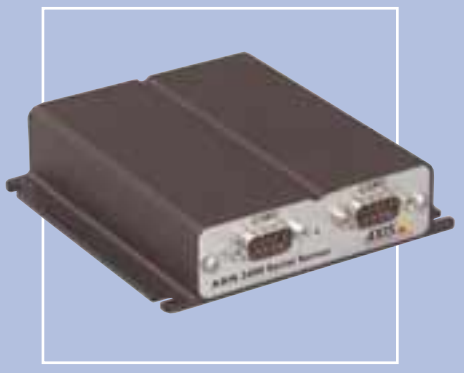
- Accommodates a single video source
- Single video loop-through output
- High-quality JPEG images (quality is dependent on the analog video source)
- Resolution 720x480 (NTSC), 720x576 (PAL)
- Frame rate 30 fps (NTSC, 352x240), 25 fps (PAL, 352x288)
- RS 485/422 port for pan/tilt control
- 4 alarm inputs, 1 output
- Supports PAL and NTSC video sources

AXIS 2460 Network DVR

- 4 analog inputs
- 1 Ethernet port
- 4 alarm inputs
- 1 trigger output
- APViS™ (Axis Prioritized Video Storage) technology (patent pending)
- JPEG compression
- Can be configured with up to four hard disks
- Based on Linux OS
- OS on flash memory

AXIS 2490 Serial Server

- Connects legacy serial devices with no Ethernet port directly to the network
- Includes built-in Web server
- 10/100 Mbit Ethernet connection
- Two RS 232 ports and one RS 485/422 port
- Password protection and IP address filtering



802.11b Wireless Access Point and 802.11b Wireless Device Point

802.11b Wireless Access Point (sender) and
802.11b Wireless Device Point (receiver)

- 2.4 Ghz ISM Band Direct Sequence Spread Spectrum (DSSS) 802.11b
- 11 Mpbs Wireless LAN Products
- TCP/IP, IEEE 802.3 and IEEE 802.11b
- 1/2/5.5/11 Mpbs with rate adaptation
- All OS support WEB interface
- 802.11 supports ranges up to 300 meters outdoors, 50-100 meters in office environments

AXIS 2191 Audio Module

- Easy access real-time audio and video
- Two-way audio communication via Internet Explorer
- No extra software required

AXIS Camera Explorer software

Installed in a PC or Pocket PC, AXIS Camera Explorer (ACE) is a low-end software package that allows video to be viewed from an unlimited number of Axis video products over both wired and wireless networks.

Suitable for most Windows PCs and Pocket PC 2002, it also supports programmable camera switching so that users can create simple patrol-and-guard applications. In addition, the PC version supports AVI file extraction, 'PTZ' camera control, and 'Quad' image display.

In addition to ACE Software, Axis cooperates with over 100 development companies to provide software which suits all kinds of different applications.

Power over LAN Midspan.

Power over LAN Midspans and Active Splitter

- Connects to existing Ethernet or Fast Ethernet infrastructure via any standard Category 5 cabling
- The Power over LAN Midspan is fully compatible with IEEE 802.3 standard
- IEEE 802.3af compliant, enabling compatibility with PoE products
- Available with 1, 6 or 12 ports

Power over LAN Active Splitter.

Glossary

AGC (Gain Control)
Adjusts the exposure gain to get good light level in the image, only used during very poor light conditions, disadvantage is noise in the picture.

Bit
The smallest measurement of information stored on a computer, a single bit can be one of two logical values: 0 or 1. 8 bits equals 1 byte. An 8-bit image supports 256 colors or grayscales; and a 24 or 32-bit graphic supports true color.

Byte
As a unit of storage a byte represents a single character on most modern computers, and comprises of 8 bits.

CCD
Charge Coupled Devices (CCDs) are large-scale integrated circuits containing hundreds of thousands of photo-sites (pixels) that convert light energy into electronic signals. It is these light-sensitive imaging devices that are used within most modern surveillance cameras. CCDs are measured diagonally and can be 2/3", 1/2", 1/3" or 1/4" or even smaller.

Client/Server
Client/server describes the network relationship between two computer programs in which one program, the client, makes a service request from another program, the server, which fulfils the request.

CMOS
Complementary Metal Oxide Semiconductor. CMOS is a widely used type of semiconductor for memories. Can also be used as image sensor in low end cameras.

DNS
The domain name system (DNS) is the way that Internet domain names are located and translated into IP (Internet Protocol) addresses.

EXview
EXview HAD CCD is a trademark of Sony Corporation. An EXview HAD Charged Coupled Device (CCD) employs an HAD (Hole-Accumulation Diode) sensor to drastically improve camera sensitivity in the near infrared light region. This technology makes it possible for surveillance cameras to effectively 'see' in the dark by irradiating near infrared light invisible to the human eye.

Field
A field is half a frame, see below.

Frame
A frame is a complete video picture. In the 2:1 interlaced scanning format of the NTCS and PAL formats, a frame is made up of two separate fields of 262.5 or 312.5 lines interlaced at 60 or 50 Hz to form a complete frame which appears at 30 or 25 Hz. In video cameras with a progressive scan, each frame is scanned line-by-line and not interlaced; most are also presented at 30 and 25 Hz.

FTP (File Transfer Protocol)
FTP (File Transfer Protocol), a standard protocol, is the simplest way to exchange files between computers on a network.

Giga Bytes
When notation is used, Giga stands for 10 to the 9th power and is expressed numerically as 1,000,000,000. Large amounts of data may be expressed in terms of kilobytes (1,024 bytes), megabytes (1,048,576 bytes), and gigabytes (1,073,741,824 bytes). Note: one (1) byte is equal to eight (8) bits.

Hub
In data communications, a hub is a place of convergence where data arrives from one or more directions and is forwarded to one or more other directions.

HTML (HyperText Markup Language)
The Hypertext Transfer Protocol (HTTP) is the set of rules for exchanging files (text, graphic images, sound, video, and other multimedia files) on the Web. HTTP is an application protocol relative to the TCP/IP suite of protocols, which are the basis for information exchange on the Internet.

HTTP (Hypertext Transfer Protocol)
The Hypertext Transfer Protocol (HTTP) is the set of rules for exchanging files (text, graphic images, sound, video, and other multimedia files) on the Web.

HTTPS
Describes a URL that employs data encryption for obtaining or transmitting confidential user information or private documents over the Internet. By convention, URLs requiring an SSL (Secure Sockets Layer) connection start with https instead of http.

Infrared
Infrared energy is emitted proportionately to the temperature of any object. Infrared cameras detect infrared energy - that is, light frequencies below the red spectrum that are invisible to the human eye - to see in the dark. IR light has a wavelength between approx. 760-1000 nanometres, visible light has the wavelength between approx. 380-760 nanometers.

JPEG (Joint Photographic Experts Group)
To create a JPEG graphic image a level of compression must be chosen from a suite of compression algorithms. When creating or converting a JPEG image from another format, you are asked to specify the quality of image you want. Since the highest quality results in the largest file, you can make a trade-off between image quality and file size. Officially, the JPEG file format is ISO standard 10918. The JPEG scheme includes 29 distinct coding processes although a JPEG implementer may not use them all.

Kbit
When notation is used, Kilo stands for 10 to the 3rd power and is expressed numerically as 1,000. Large amounts of data may be expressed in terms of kilobytes (1,024 bytes), megabytes (1,048,576 bytes), and gigabytes (1,073,741,824 bytes). Note: one (1) byte is equal to eight (8) bits.

LEDs
Light Emitting Diodes are discrete silicon-based components that produce a luminous light when positively charged.

LUX
The standard measurement of light, where 1 Lux equals the light emitted from a single candle at a distance of one meter.

Mbit
When notation is used, Mega stands for 10 to the 6th power and is expressed numerically as 1,000,000. Although Ethernet and Fast Ethernet networks are often referred to as 10 and 100 Mbit Ethernet networks respectively, it is technically more precise to describe these type of connections in relation to time; i.e. 10 Mps or 100 Mbps (100 Mega bits per second).

MPEG (Moving Picture Experts Group)
MPEG, the Moving Picture Experts Group, develops standards for digital video and digital audio compression. It operates under the auspices of the International Organization for Standardization (ISO). The MPEG standards are an evolving series, each designed for a different purpose.

To use MPEG video files, you need a personal computer with sufficient processor speed, internal memory, and hard disk space to handle and play the typically large MPEG file (which has a file name suffix of .mpg). You also need an MPEG viewer, or client software that plays MPEG files.

Note that .mp3 file suffixes indicate MP3 (MPEG-1 audio layer-3) files, not MPEG-3 standard files. You can download shareware or commercial MPEG players from a number of sites on the Web.

Quads
A Quad displays images from up to four cameras on a single screen.

Router
A router is a device that determines the next network point to which a packet should be forwarded towards its final destination. Connecting between at least two networks, the router uses its understanding of the current state of the network to determine which way to send each information packet. A router can be located at any juncture of a network or gateway, including each Internet point-of-presence. A router is often included as part of a network switch.

RS-232
RS-232C is a long-established standard ("C" is the current version) that describes the physical interface and protocol for relatively low-speed serial data communication between computers and related devices.

RS-422
RS-422 is designed to replace the older RS-232 standard. By employing differential pair signaling that transmits one signal in opposing states over two wires, this transmission format supports higher data rates and greater immunity to electrical interference than offered by the existing RS-232 standard.

RS-485
RS-485 is an upgraded version of RS-422 with the added capability to allow up to 32 devices (transmitters and receivers) to share the same.

Server
In general, a server is a computer program that provides services to other computer programs in a network.

SSL
SSL (Secure Sockets Layer) is a program layer created by Netscape for managing the security of message transmissions in a network. Netscape's idea is founded on the principle that the programming associated with keeping your messages confidential ought to be contained in a program layer between an application (such as your Web browser or HTTP) and the Internet's TCP/IP layers.

Subnet Mask
A class B Internet address comprises of two components: the network address and the host address. And, 'subnetting' enables a network administrator to further divide the host part of the address into two or more subnets.
A subnet mask is used to identify the subnet to which an IP address belongs. By performing a boolean AND operation on the bits comprising the mask and the IP address, the subnetwork address can be derived.

Example:
Subnet Mask 255.255.240.000 11111111.11111111.11110000.00000000
AND
IP Address 150.215.033.009 10010110.11010111.00100001.00001001
=
Subnet Address 150.215.032.000 10010110.11010111.00100000.00000000.

Switch
A hub is transmitting all data to all devices that is connected to it and that is a huge disadvantage. If you use a switch, data will only be transmitted to the device that should receive it. We recommend you to use a switch in stead of a hub.

TCP/IP
TCP/IP (Transmission Control Protocol/Internet Protocol) is the basic communication language (or protocol) of the Internet. It is also used as a communications protocol in private networks called intranets, and in extranets.

The IP address
The 32-bit IP address is often referred to as a dot address (sometimes called dotted quad notation) - that is, four groups (or quads) of decimal digits separated by periods. Here's an example: 130.5.5.25

URL
An abbreviation of Uniform Resource Locator, this specifies the global address for resources made available over the Web. The first part of a URL address specifies what protocol to use, whereas the second defines the IP address or the domain name at which the resource is located.

VCD
Stands for Video Compact Disc. An extension of CD based on MPEG-1 video and audio format that allows playback of near-VHS-quality video on a video CD player, or computer with MPEG decoding capability.

Web server
A Web server is a program, which allows Web browsers to retrieve files from computers connected to the Internet and network.

xDSL
The collective description for all types of digital subscriber lines; including ADSL, SDSL, High-data-rate DSL (HDSL) and Very high DSL (VDSL). xDSL technologies operate over existing copper telephone lines, but offer much higher transmission speeds – with up to 32 Mbps for upstream traffic, and from 32 Kbps to over 1 Mbps for downstream traffic.

Legal considerations

Laws regarding the use of camera surveillance vary from country to country may prohibit camera surveillance, so check your local laws before using cameras.

Liability

Axis Communications AB cannot be held responsible for any technical or typographical errors in this guide.
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About Axis

Axis increases the value of network solutions. The company is an innovative market leader in network video and print servers. Axis' products and solutions are focused on applications such as security surveillance, remote monitoring and document management. The products are based on in-house developed chip technology, which is also sold to third parties.

Axis was founded in 1984 and is listed on the Stockholmsbörsen (XSSE:AXIS). Axis operates globally with offices in 14 countries and in cooperation with distributors, system integrators and OEM partners in 70 countries. Markets outside Sweden account for more than 95% of sales. Information about Axis can be found at **www.axis.com**

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